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Volume XXV APRIL, 1938 Number 2

CONTROL OF INTERSTATE WATER POLLUTION

BY THORNDIKE SAVILLE *

(Presented at a meeting of the Boston Society of Civil Engineers held on January 26, 1938)

THE citizens of the United States have long been taught that sovereignty in this country resides in the States, and that the powers of the Federal government are restricted to those specifically delegated to it by the States, as set forth in the Constitution. Administrative control of water pollution is, in the great majority of cases, fundamentally an exercise of the police power, the most extensive and least capable of restriction of any governmental power, and one which the States carefully refrained from delegating to the Federal government.

By the exercise of this power most States have enacted laws to control the pollution of state waters, and delegated their enforcement to appropriate state agencies. Although much more has been accomplished by state agencies with respect to pollution abatement during the past ten years than is frequently assumed, none the less many of our streams are still in a deplorable condition, and in some instances the degree of water pollution is on the increase. This has produced an awakened public interest in water pollution control, providing an important problem for intelligent leadership on the part of engineers and legislators.

There are numerous aspects of pollution abatement which have to be weighed from technical, social and administrative points of view. The principal sources of pollution are municipal sewage and industrial

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* Dean, College of Engineering, New York University, New York, N. Y.

wastes. Likewise, municipalities and industry represent the most important, even if not the most vociferous, interests in protection of waters from pollution, through their necessities for pure domestic water supply and process water. The fisheries industry, the sportsmen and those concerned with provision of adequate recreation facilities for the public are properly concerned with protection against or alleviation of water pollution. There are thus important public and private interests, large social and economic considerations, as well as effective legislative and administrative practices to be weighed, analyzed and decided. No simple or general formula can possibly be devised to produce a panacea for the numerous interests, all of them important, many in apparent conflict, and most of them requiring procedures based upon a particular local or regional set of circumstances.

It is not surprising, therefore, that numerous groups, particularly those concerned almost entirely with the use of streams for sporting or other recreational purposes, have become impatient with the apparent slow progress of water pollution abatement, and somewhat hysterically call for large scale immediate alleviation of the situation by vesting new police powers in the Federal government. It is contended by the proponents of such action that the local authorities have been dilatory in constructing sewage treatment plants; that industry has been unwilling to seriously attempt mitigation of industrial waste pollution; that investigations of polluted waters have now furnished adequate information so that additional study serves only to delay remedial action; that state boards of health have been intimidated by vested interests or political considerations; and that in consequence there remains only interposition of the Federal government for effective regulation of water pollution.

Conditions Affecting Water Pollution Control

There are now pending before the Congress of the United States a number of measures designed to afford a greater or less degree of Federal control over stream pollution. It is therefore especially timely for renewed consideration of the topic assigned to me, "Control of Interstate Stream Pollution." Since in my personal opinion sound practices aimed at water pollution control will almost automatically be applicable to interstate as well as intrastate waters, I should prefer to deal, first, with the broader problem, and consider with you some of the more important factors which are alleged to have delayed or are delaying abatement of water pollution.

I. Imperfections of State Regulation

(*a*) *Inadequacy of State Legislation.* — Some forty States have vested either no control or ineffective control in state regulatory agencies. Only eight States have adequate and comprehensive legislation on water pollution. However, it should be stated that experience has indicated that the presence or absence of corrective legislation is not a major factor in the control of sewage pollution. It may be in the case of control of industrial waste disposal. None the less, consideration should be given to uniform state laws relating to pollution control, since any action by state agencies is predicated upon enabling legislation. The most serious defect in existing legislation is the frequent provision for exemption from control of certain specified industries, municipalities or reaches of a river. Nineteen States have laws containing one or more such exceptions.

(*b*) *Political Pressure.* — In States where adequate powers are granted to a regulatory agency, it frequently happens that political pressure from municipalities or industry is sufficiently potent to prevent strong action by the agency. Insecurity of tenure for personnel of the regulatory agency, due in part to absence of civil service status except in fifteen States, accentuates this disability.

II. Lack of Knowledge of Control Measures

While domestic sewage may be purified to any desired degree by known methods, there are numerous industrial wastes for which control methods are either unknown or so costly as to be prohibitive.

III. Economic Considerations

(*a*) *Limitations of Municipal Debts.* — In most States there are constitutional or statutory restrictions as to the bonded indebtedness of or taxation within municipalities. When this limit has been reached, as it has in numerous instances, there is little that a State regulatory agency can do toward requiring construction of municipal sewage treatment plants.

(*b*) *Rejection of Improvements by Voters or Local Legislative Bodies.* — When expenditures are refused by municipal legislative bodies or by the voters thereof, state regulatory bodies are reluctant to bring the issue to the courts on account of difficulties in proving damages, costs of the suit, or political reprisals.

(*c*) *Costs to Industry.* — In the case of certain industrial wastes adequate disposal to abate stream pollution would impose such costs upon the industry as to cause it to cease operations, with resultant loss of taxable property. Too little attention has been given by industry to research designed to discover new uses for waste products or less costly treatment of them.

IV. Lack of Standards of Water Quality

Acceptable standards of water for domestic purposes are well established, but standards of water for use by various industries — for fish life, for waterfowl, for agricultural purposes, or for bathing and general recreational use — have either not been determined or have not received such general acceptance as to justify using them as a basis for legal proceedings. No element in water pollution control is in greater need of investigation, and hardly a beginning on the problem has been made.

V. Interstate Aspects

Most of the more seriously polluted streams of the country are interstate in character. No matter how effective control measures may be in one State, they cannot reduce pollution having its source in another State. This problem is largely one of an administrative character, but is not simple in its solution, chiefly because no matter what administrative device may be adopted, its execution will be subject to the factors just enumerated. When those difficulties have been more generally removed through a changed public sentiment, uniform State legislation and increased knowledge, the control of pollution of interstate streams will be much easier of accomplishment than at present.

While all of the reasons for delay in abatement of water pollution cited above are undoubtedly applicable in one or more instances in every State today, it is the belief of the writer that inadequate legislation is a minor factor in many regions, and is too often an excuse for procrastination and ineffectiveness of state regulatory agencies. While such agencies cannot proceed much in advance of public sentiment, they can be far bolder in trying to arouse and guide such sentiment, as has been done in other fields of public health. Limitations on bonded indebtedness and the imperfections of administration by regulatory agencies are major factors in the continuing pollution of our streams. Lack of control over industrial wastes or of knowledge as to how to control them economically are important but secondary factors.

REPORTS ON WATER POLLUTION

In 1934 special interests began to importune Federal officials and the Congress for legislation which would give to the Federal government regulatory powers over the pollution of inland waters. It seemed desirable that a thorough review be made of the status of water pollution control throughout the country, the degree to which pollution could be controlled, the progress of pollution alleviation undertakings, and the extent to which the Federal government should participate in water pollution abatement activities. The Water Resources Committee of the National Resources Committee appointed a Special Advisory Committee on Water Pollution. This Advisory Committee represented in its membership* practically every element concerned with water pollution except that of industry, and briefs were received and considered with reference to that aspect of the problem.

The Advisory Committee has rendered two reports. The first report dated May, 1935, was essentially a fact-finding document dealing with the existing status of water pollution law, public health aspects, biological aspects other than public health, industrial waste treatment, and standards of water quality. It contained various suggestions for improving the defects reported in each of these categories. Two years later, in May, 1937, a second report† was issued, in which extended attention was given to the marked progress accomplished in the alleviation of water pollution, and recommendations with respect to Federal participation were made. A summary of the findings of this report indicated:

> "Progress in water-pollution abatement during the past five years has been unprecedented.
>
> "Approximately half of our urban population is served by sewage-treatment plants. In 1932 only 31 per cent of the urban population was tributary to plants. This change marks an increase of more than 70 per cent in population served during a five-year period, resulting in a great reduction in amount of raw

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* W. B. Bell, Chief, Division of Wildlife Research, United States Biological Survey; A. C. Fieldner, Chief, Technologic Branch, Bureau of Mines; Elmer Higgins, Chief, Division of Scientific Inquiry, Bureau of Fisheries; Thorndike Saville, Dean, College of Engineering, New York University; William A. Snow, Major, Corps of Engineers; R. E. Tarbett, Senior Sanitary Engineer, United States Public Health Service; Abel Wolman, Chairman, Chief Engineer, Maryland State Department of Health.

† Second Report of the Special Advisory Committee on Water Pollution and Summary of State Legislation Affecting Water Pollution. Water Resources Committee, National Resources Committee, Washington, May, 1937.

sewage reaching our surface waters annually. The rapid progress in sewage-pollution abatement is due almost wholly to Federal financial aid. Much work, however, remains to be done. An expenditure of at least $500,000,000 would be required to provide treatment for the sewage from three fourths of our estimated urban population in 1941. This estimate, however, does not provide for the very considerable cost which would be entailed for the construction of industrial wastes treatment plants.

"Abatement of pollution from industrial waste proceeded less rapidly and less uniformly. In some industrial areas notable progress was made; in others the lack of economical treatment processes, or inertia, prevented any substantial reduction of waste. It cannot be too strongly stressed that the problem of industrial wastes recovery and disposal is essentially a responsibility of private industry. It is a responsibility which the committee feels private industry has not met with as much interest, enthusiasm and financial support as it should. Restrictive legislation would be unnecessary if industry would face this issue squarely.

"One of the difficult problems remaining, however, is how to provide adequately for the treatment or recovery of industrial wastes in cities where such plants are not connected to the city sewers or treatment plant. This situation prevails in numerous metropolitan areas. The volume and deleterious effects of such industrial wastes from unconnected plants frequently exceed those of domestic sewage. The financial and administrative aspects of this problem are still unsolved. Unfortunately, in many of our largest urban areas the subject is being disregarded. In these areas domestic sewage is being purified while large volumes of highly objectionable industrial wastes continue to empty into the same receiving bodies of water.

"During the same five-year period, approximately 800,000 to 1,000,000 tons of sulphuric acid flowing annually from abandoned mines in the Appalachian coal fields were controlled by mine-sealing operations. An equal load from abandoned mines and an even larger load from idle or active mines are still uncontrolled.

"Federal loans and grants were undoubtedly responsible for the great stimulation of pollution-abatement work during the five-year period. The Special Advisory Committee considers that, under proper control and co-ordination, the grant-in-aid principle may be used to advantage in speeding up pollution abatement in the United States.

> "No basic changes in Federal law with reference to Federal regulation of pollution should be made until there has been further experimentation. However, extension of Federal interest and participation in local and regional pollution-control measures is recommended.
>
> "The Committee recommends that, if new Federal pollution-control legislation is considered, it should have the following provisions:
>
> "1. Designate a Federal agency to study and report on water pollution and pollution-abatement projects.
>
> "2. Provide for loans and/or grants to public agencies, and loans to non-public agencies for pollution-abatement works.
>
> "3. Provide that loans or grants be approved by an overlying public works agency.
>
> "4. Provide that loans or grants be cleared with a water-resources planning agency to insure reconciliation of pollution-abatement work with the comprehensive utilization and control of water resources in the drainage areas affected.
>
> "5. Give congressional consent to negotiation of interstate compacts for pollution abatement.
>
> "Whatever pollution-control agency may be created, it is important that experimentation in basin-wide study and administration of pollution abatement be initiated promptly. The Potomac Basin is recommended as the demonstration unit for such work."

The recommendations for Federal participation in water pollution abatement activities described above were substantially incorporated in the Barkley-Vinson bill introduced into the last Congress. These recommendations failed to embody one major proposal of the so-called conservationists, really those special interests concerned primarily with fish and wild life protection and recreation. This was provision for Federal regulatory powers. Several bills have been introduced either into the past or present Congress providing for various degrees of Federal control and the administration thereof. That which is now receiving the greatest attention is the Barkley-Lonergan bill, which contains the essentials of the Barkley-Vinson bill, but provides in addition for: (*a*) the consent of Congress to interstate compacts for pollution abatement purposes; (*b*) the classification of the navigable waters of the country into sanitary water districts and the fixing of standards of purity for navigable waters and their tributaries; and (*c*) the declaration by Congress of discharge of any waste materials or substances into navigable waters or their tributaries to be against public policy and subject to restraint through an action by any United States attorney in a Federal court.

Administrative Control of Water Pollution

The writer has previously presented a fairly comprehensive analysis* of the powers of Federal, state and other agencies of government with respect to administrative control of water pollution. There are various expedients which may be utilized to effect Federal regulatory control over most of the more highly polluted streams of the country. These will be based, however remotely, upon navigation, treaty obligations, hydro-electric power production, or even flood control, on all of which there exists important Federal legislation. Irrespective of how one may *think* the police powers of the Federal government should be restricted, it is the belief of the writer that Federal regulation of stream pollution can be legally achieved. The question is, does the public interest demand this extension of Federal control? If so, interstate streams would doubtless be a major consideration in any Federal policy for the regulation of water pollution.

The writer is one of those who believe that better administrative procedures for stream pollution control can be devised than by placing the regulatory responsibility upon the Federal government. Even in the case of interstate streams, pollution control is essentially a local matter not susceptible to standardized procedures or regulations. The classification of streams and determination of standards of purity provided for in the Barkley-Lonergan bill would take many years, and might well delay rather than accelerate control measures. Furthermore, assuming even that the States are impotent in the enforcement of existing stream pollution legislation, there is no assurance that the Federal government would be less so. Experience to date is to the contrary. The International Joint Commission began consideration of the pollution of the Great Lakes and tributary streams as long ago as 1910, but no Federal action has yet been taken to reduce the serious pollution of certain of these waters. The Secretary of War ordered the Chicago Sanitary District to materially reduce its diversions from Lake Michigan used to dilute its sewage discharged through the Chicago Drainage Canal in 1925, but the District defied this order. Subsequently the United States Supreme Court in 1929 handed down a decision ordering a progressive decrease in withdrawals through the Canal, but so little effect did this have that the complainant States protested to the Federal authorities three years later. It was not until the emergency grants of Federal funds became available to Chicago in the past five years that essential compliance with Federal orders was effected. These cases seem to prove that the Federal government may be a no more potent or expeditious regulator of pollution abatement than state or local authorities. If not, the chief argument for Federal control is seriously weakened.

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*"Administrative Control of Water Pollution," by Thorndike Saville. Transactions, American Institute of Chemical Engineers, 1931.

Another device for effecting control over interstate streams is the interstate compact. This has been widely advocated, and should be further explored. Only one such compact has been consummated, — that between New Jersey and New York affecting the coastal and tidal waters in the Metropolitan New York region. While the provisions of this compact were carefully prepared, their execution is still in an experimental stage, although the compact was approved by Congress in 1935. Drafts of interstate compacts have been prepared dealing with pollution control on the Ohio and on the Delaware Rivers. The interested States have not yet approved them for submission to Congress.

The interstate compact as thus far developed appears to the writer to have two serious defects. The first is that existing or proposed compacts are administered by commissioners who are political appointees. It would be better if at least one of these commissioners from each State was required to be selected from a panel of private consulting engineers presented by a state or national civil engineering organization. The second defect is the growing possibility that Congress may refuse to approve compacts unless they conform to certain general policies which may be of a transient character, may be objectionable to the States involved, or may even not affect the major purposes of the compacts. Such an eventuality would produce Federal control in an indirect manner.

A third procedure is for one or more States to institute suit in the Supreme Court as complainants against another State. This has been done, and results not only in a form of Federal control, but may cause the Supreme Court to exercise administrative rather than judicial functions, as may yet be the case in the Chicago Drainage Canal, Delaware River, and Connecticut River controversies.

A fourth procedure for control of interstate water pollution is an informal agreement between the regulatory agencies of the interested States, usually the state boards of health. Such agreements are in effect among the state health departments concerned with pollution of the Ohio River and the Great Lakes. These agreements relate primarily to exchange of information and establishment of broad policies for the control of specific industrial wastes. While undoubtedly helpful, such agreements have not been proved to be effective instruments for pollution control of interstate waters.

THE DEVELOPMENT OF INTERSTATE AGREEMENTS

Having discussed briefly the present aspects of Federal control of water pollution, I should like to develop a somewhat different line of thought directed toward interstate initiation and control of water pollution as part of a co-ordinated water conservation policy and program. Let us take a large river system known to be polluted at various places and in varying degree. From the standpoint of local and state agencies the procedure would probably be somewhat as follows:

I. Factual Investigation

We should endeavor to secure the requisite facts upon which to base our judgment for the character of pollution abatement works required. These are —

1. Locate the points of discharge of sewage and industrial wastes.
2. Investigate the quantity being discharged at each point, including variations in rate of discharge, both daily and monthly.
3. Investigate the character of the sewage or industrial waste, including its chemical, physical and biological aspects, and the daily and monthly variations.
4. Determine the daily and monthly discharge of the river and its tributaries at a sufficient number of selected points so that reasonably accurate estimates of flow can be made for places where it is required to abate the pollution load.
5. Determine the chemical and biological characteristics of the stream at the same points if possible. Otherwise, determine them at other selected points.

Manifestly such an investigation requires interstate co-operation to agree upon the adequacy of sampling points, the standardization of procedures to produce comparable results, and the preparation of a report presenting facts which may receive general acceptance. All of this is merely a preliminary factual study, but it requires care in preparation and compromise in assumptions necessary because of lack of adequate long-time records of the several phenomena being studied.

These factual preliminary studies require co-operation from several state health departments, state conservation or water supply commissions, several Federal agencies, such as the Geological Survey, the

Weather Bureau, etc., and from many industries. It is perhaps in this phase of the study more than any other that a single Federal agency may be helpful if, as is contemplated in certain of the bills now before Congress, there is created in it a special engineering bureau charged with water pollution investigations. Such an agency can establish the necessary standardized procedures and perform much of the investigatory work in co-operation with local and state organizations.

II. Social and Economic Aspects of Pollution

It is necessary now to interpret the data which have been assembled with respect to the relation of pollution abatement to specific objectives. The more common of these are —

1. Public water supply.
2. Recreation.
3. Industry.
4. Navigation.
5. Fish and wild life.
6. Agriculture.
7. Nuisances.

Any extended discussion of each of these is impracticable in this address. A few typical illustrations of some of the problems will suffice. The river is used as a source of public water supply at a certain point. To what degree must the pollution load be abated to furnish a water safe for human consumption after treatment by ordinary water purification processes? To what degree must sewage be treated at various points above to reduce the pollution abatement in the most economical manner? To what extent are measures for water purification, sewage and industrial waste treatment, and increase of low water flow from storage warranted to produce the results desired at minimum cost?

One industry discharges objectionable wastes into the river. The same industry, or another industry, requires expensive water treatment processes to produce from the river a water satisfactory for its operations. To what extent shall the several industries in the Basin be required to treat their wastes on the one hand, or to treat the water they receive on the other hand? The economics of industrial waste treatment and of industrial water treatment vary for nearly every industry, and are in turn related to public water supply treatment and to public sewage treatment. The answer to this single problem of industry and pollution has innumerable ramifications.

And so one might go on, raising complex relations between each of the social and economic aspects of pollution listed above. The investigation and evaluation of relative values from a pollution standpoint alone is almost staggering to contemplate. Yet if these relations are not carefully weighed, the problem is not only unsolved, but unforeseen complexities will arise which may indefinitely postpone effective action to bring about anything more than temporary local pollution abatement.

Here again the same diversity of state and local, public and private, concern must be considered, as in the example of collection of factual data described previously. Here again, to investigate, co-ordinate and report, a Federal agency may well be the most effective instrumentality, working in co-operation with state and local interests.

III. Relation of Pollution Abatement to Other Water Control Measures

Thus far we have collected and analyzed the factual data relating to pollution, and we have determined a plan of pollution abatement which will produce the desired results with due regard to social and economic factors. Why not go ahead and put our plan into effect without further loss of time? Probably this can be more safely done in the case of pollution abatement than with any other phase of water control and conservation, since most pollution abatement measures will fit readily into almost any general water conservation plan. However, let us see how we might well consider the relation of pollution abatement procedures to some of the following:

1. Future water supply development.
2. Hydro-electric power development.
3. Navigation.
4. Flood control.
5. Recreation (including fishing, boating, bathing).
6. Low water control.
7. Irrigation.
8. Industrial water use.

Again, space limitations permit only a few typical problems to be raised. May it be more economical and even more socially desirable to permit water pollution, keeping it only at a stage where no nuisances would arise, and to develop new regional or district water supplies from relatively unpolluted sources, and to provide new recreational water facilities?

Could not flood control projects be so designed and operated as to contribute to increasing the low water flow of the stream? If so, could not the degree of sewage and waste treatment be reduced at various places, and part of the combined flood control and regulatory reservoir be charged to pollution abatement, since the increased low water flow would provide dilution requiring less expensive sewage or waste treatment plants? At the same time, industry might be provided with a less saline water in certain parts of the river, and thus be willing to substitute contributions to storage reservoir construction for the cost of industrial water treatment otherwise required.

The last Congress enacted a flood control act which seems to me defective in certain particulars, especially as to possible relation to water pollution. It authorized numerous flood control reservoirs with little or no consideration of their relative merits, the part they might play in pollution abatement or power development, or related functions. The assessment of cost is likewise inequitable, and there is no provision in the act for such reservoirs serving multiple purposes, including alleviation of water pollution, nor for an equitable assessment of costs in consideration of purposes other than flood control which such reservoirs might serve.

The brief illustrations which I have given will, I hope, cause you to view with concern any expenditures by any governmental agency (Federal, state or local) for water conservation and control, whether for pollution abatement, or flood control, or public water supply, or for any other *single* purpose, unless the subject for which the expenditure is to be made demonstrably fits into a co-ordinated scheme for the most efficient and economical development of the water resources of the drainage basin in which the project is located.

Conclusions

It is my belief that no new Federal regulatory legislation is needed, but that there might well be set up in the United States Public Health Service a Division of Water Pollution Control which, in co-operation with state, local and private agencies, would undertake investigations such as those described in Items I and II of the preceding section of this paper.

The Federal government, through some public works agency, should be empowered to make loans and grants to state and municipal authorities, such as interstate river districts, sanitary districts, municipalities, etc., for constructing pollution abatement works.

Both water pollution investigations and financial contributions to pollution abatement works by the Federal government should be cleared through a water resources planning agency, such as the Water Resources Committee of the National Resources Committee, to insure reconciliation of pollution abatement work with the comprehensive utilization and control of water resources in the drainage areas affected.

Congress should grant consent to the negotiation of interstate compacts to promote the orderly development and use of the water resources of interstate streams, pollution abatement being always an important element in any program of water control and use. Efforts should be made to develop a more or less standardized form of compact which would be extremely broad in character, permitting state initiative and control subject to Federal regulation only in specific matters coming properly under Federal jurisdiction.

Acting under such compacts state and interstate agencies should be created to administer the physical development of drainage basins or of river districts. Such agencies should adequately represent the various public and private interests in river regulation, and might well have some official relation with the Federal water planning agency. It is highly important that there be a sprinkling of private engineers, lawyers and industrialists on such agencies. This idea is patterned somewhat after the Rivers Board of Great Britain, and was advocated by me as an approach to control of pollution on interstate streams in an address before the American Institute of Chemical Engineers in 1931. More recently, Dr. Arthur Morgan has formulated a specific procedure whereby under an act of Congress drainage basin authorities could be created by application to a Federal Court of Appeals.* This proposal is likely to receive a good deal of consideration during the next few months, and I commend it to your serious attention.

The Federal government should create on a permanent basis some co-ordinating and investigatory water resources agency, which should be charged with co-ordinating the water resources activities of various Federal bureaus, with promoting co-operation between Federal and state agencies, and with proposing orderly programs and Federal policies designed to promote the development, control and use of the water resources of the nation.

In all of this promising steps have been taken. Bills are in Congress proposing the creation of a Water Pollution Control Division in the United States Public Health Service. The Public Works Administration has until recently made loans and grants to public agencies for water pollution abatement projects. The Water Resources Committee of the National Resources Committee has recently completed a second progress report on the major drainage basins of the country.

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* "A Statute for River Development," by Arthur E. Morgan. Engineering News-Record, January 6, 1938.

This report lists the principal water problems in each basin, outlines in broad terms an integrated pattern of water development and control designed to solve those problems, presents specific construction projects as elements of an integrated pattern or plan, with general priorities of importance and time. This report and its predecessor are the first efforts ever made by the Federal government to view the major water needs of the country in the light of a developing national water policy. Many in this audience participated in the preparation of these reports and have been made aware of at least one procedure whereby the Federal government may constructively assist but not control or regulate state and local activities.

I think it may fairly be said that we are making great strides as a nation in the orderly scientific and engineering study of our water resources. We must proceed intelligently and soundly to evaluate all of the related factors in water resources control, and we must try to prevent enthusiastic but ill advised efforts to develop overnight panaceas for one or another single factor. Temporary advances in water control administration and practice gained during the times of emergency should be maintained, improved and made permanent.

It seems to me that most aspects of the control of interstate water pollution are logically to be considered in their relation to an evolving national water policy. I should therefore like to conclude by setting forth the major characteristics of such a policy as enunciated by the Water Resources Committee.*

> "1. It will be concerned, in the final analysis, not with water *per se*, but with the promotion of public safety, public health, the public convenience and comfort, the economic welfare of the public, the establishment or maintenance of a high standard of living.
>
> "2. It will seek to promote the maximum integrated use and control of water, within the shifting limits imposed by considerations of technical feasibility and of economic and social justification.
>
> "3. It normally will treat drainage areas as units with respect to their waters in recognition of the train of connected problems that runs from river source to river mouth, from countless rivulets

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* "Drainage Basin Problems and Programs." National Resources Committee, Washington, D. C., December, 1936.

along the highland rim of the largest basin to the distant point where its master river enters the sea.

"4. Though treating drainage areas as units, it will scrupulously observe the rights of the several States both in intrastate and interstate streams, seeking through co-operation to promote the full use of water in the best ways and in the proper places.

"5. It will recognize and abide by the axioms that facts are indispensable prerequisites to sound action with respect to water, and that conclusions and commitments not based on predetermined facts almost certainly prove indefensible. In keeping with this recognition, it will promote by all feasible means continuous assembly of the basic data essential for an evolving, unending water plan. At the risk of repetition, the statement may be made categorically that the adoption of a plan and program for the use and control of the waters of any river basin without a definitive study of adequate data bearing on all phases of the interlocking physical and cultural problems involved would be illogical, would result in economic waste, would invite controversy, and might preclude desirable action later. As already noted, controversies over water multiply. They are most likely to arise where pertinent facts are least known. An enlightened water policy will seek to obviate controversy by substituting facts for opinion.

"6. It will assign the cost of constructing and operating projects undertaken from time to time as suitable elements in an evolving water plan among the agencies concerned in as close accordance as possible with the distribution of benefits. The proposition that those who will profit from a given undertaking normally should pay, in a manner not involving avoidable or undue hardship, in proportion to the advantage they will reap should be the basic principle of action.

"7. In determining whether or not water projects are justifiable, and in distributing the costs of meritorious projects among the beneficiaries, it will take properly into account social benefits as well as economic benefits, general benefits as well as special benefits, potential benefits as well as existing benefits, wherever they are involved. Some of these benefits are not capable of measurement, and accordingly they commonly have been ignored in the past in evaluating certain types of enterprises. They are subject to reasonable appraisal, however, and their intangible nature will not justify their neglect in the future. In great measure, they concern the public at large. A public water policy should assiduously conserve and promote public interests. To this end, social accounting must take its place with economic accounting. As effective water planning proceeds year after year without interruption, — planning based on fundamental and exhaustive engineering, economic and social studies that cover all relevant conditions, — there inevitably will result not only a clearer understanding of what constitutes the public interest, but also a greater opportunity to promote it through equitable control and orderly development of water resources."

TIDAL DATUM PLANES AND THEIR USE IN ENGINEERING

By Elliott B. Roberts*

Introduction

Surveyors and engineers of the past have all too frequently used local and purely arbitrary datum planes for their surveys. This, though often done with valid reason, has resulted in confusion and loss. Many recent surveys cannot be compared with earlier ones. Contiguous surveys made on different unrelated datums cannot usually be joined successfully. Even supposedly identical or related planes *determined from water level readings* have often proven to be actually unrelated, because of inadequate determination or impermanent referencing. This supposed but actually non-existant relationship has itself contributed to the eventual confusion; doubtless this has been so in the Boston area.

In this day of wide extension of surveys for highway, power, conservation, mapping, and other uses, much economic loss is entailed in our inability to use earlier surveys, the major faults of which were simply lack of correlation. This is the penalty attending the use of impermanent datum planes.

The obvious cure for this inefficiency is the use of rational datum planes, fixed and forever recoverable. To the greatest extent possible, in view of the nature of the datum planes and the requirements of the surveys, the number of different datums should be kept to a minimum. Except for very special needs, surveys should be correlated by use of a single, nation-wide datum.

Bench marks have mortality through erosion, tilling, land instability, construction, etc. Something more lasting is needed for the referencing of datum planes. Notwithstanding failures of some early datum planes based on water levels, the search for a rational datum plane has led inevitably to the use of the ocean water surface. Since this fluctuates with the tides, it is not itself directly available as a reference surface. The fluctuation being essentially systematic, however, analysis permits the determination of fixed planes definitely related to the tidal motion.

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In most ways these satisfy our needs admirably; however, their nature places certain limitations on their determination and use. Of tremendous importance are the facts that tidal datum planes *at a given place* are simple of definition, certain of recovery, and accurate of determination. It must be understood, however, that their determination, though accurate, is by no means simple. They are, furthermore, local in character. There is no tidal datum plane which in its aggregate everywhere comprises a single, geometrically perfect datum surface. One, however, the plane of *mean sea level*, approaches closely enough to this ideal so that, with due care and slight generalization, it has successfully been adopted as the basis of the *mean sea level datum*. This is the desired single nation-wide datum surface for general survey correlation.

DEFINITIONS

It has been stated that tidal datum planes are simple of definition. The following are definitions of those commonly used in the eastern United States as bases for published bench mark data:

Mean high water is the mean of all high water levels.

Mean low water is the mean of all low water levels.

These planes have intimate relation to tidal conditions in local areas, such as Boston Navy Yard, Fort Point Channel, or Weymouth Fore River. Their elevations are not constant from place to place.

Half tide level is the arithmetic mean of the foregoing. It is closely similar to, but must be distinguished carefully from —

Mean sea level, the mean elevation of the water surface, considering all stages of the tide. Theoretically its determination requires integration of the curve drawn by an automatic tide gage. In practice a very close approximation is obtained by averaging the hourly readings scaled from such a curve. The aggregate of the mean sea level surfaces of all places approaches most nearly to the ideal of a general surface of equal elevation. In this discussion, the term *local mean sea level* will be used to direct attention to specific local instances, and *mean sea level datum* will be employed for the generalized concept comprising the unified national height datum.

Other tidal datum planes are used in certain places to suit special conditions, notably, the plane of *mean lower low water*, the chart datum on the Pacific coast and elsewhere that diurnal tides prevail; that is, where each alternate tide is materially lower than those intervening. These special planes will not be discussed.

Tidal bench marks are purely local to the site of an existing or former tide station, referring to the mean high, mean low, and half tide levels established at that station alone. They are not usually referred to local mean sea level, which may not coincide at that place with the more significant mean sea level datum. To do so might defeat the very purpose of the single national datum.

Geodetic bench marks are referred to the mean sea level datum, and constitute a unified national system.

DETERMINATION OF LOCAL TIDAL DATUM PLANES

Observation of tides by the United States Coast and Geodetic Survey dates from the earliest work of chart surveying by the Bureau. The original purpose was the determination of a reference plane for charted soundings, and the reduction of the soundings to that plane, it being obviously impracticable to make all soundings at a single stage of tide. A later and far more widely known application of the work has been the formulation of the tidal characteristics at each of numerous places, and the publication of resulting predictions of future tides — data vital in coastal navigation.

It has been stated that the determination of tidal datum planes, though accurate, is not simple. A brief discussion of the difficulties is given for those who may have occasion to make such determinations.

Primary Determinations

Independent original determinations necessarily involve very long observation periods to average the fluctuations continually occurring in the rise and fall of the tide. Observations of limited duration may be in error, due to temporarily unbalanced meteorological conditions or failure to balance out the long-period cyclic components of the curve.

Temporary Fluctuations of Meteorological Origin. — These may be caused by abnormal barometric conditions, disturbances to the normal rise and fall caused by strong winds, etc. Low barometric pressure may cause heightened water levels, and *vice versa*, on any body of sea water, whereas disturbances in the levels due to wind are most marked in estuaries and shallow bays. While such fluctuations may amount to several feet over a period of days, the error reduces to negligible proportions with increasing length of observations. In this connection, almost all Bostonians know the effect of northeasters in bringing abnormal high tides to Boston Harbor.

Long Period Fluctuations. — Distinguishable from the foregoing are cyclic fluctuations due to the presence in the tide curve of many components of longer period than those of the moon and sun, which are, respectively, about 12.4 and 12 hours. At least 37 components have been distinguished in the analysis of certain tide curves.

Fig. 1 illustrates how the monthly mean values vary from the well-determined long period mean.

Length of Observation required. — Because of the fluctuations described, mean elevations resulting from a month of observation may be a foot or more in error. Even those from a whole year of record may vary a quarter of a foot from the long-time mean. Analysis of tide curves shows that nineteen years of observations may be considered, within close limits of error, to balance all significant components, and therefore to constitute a tidal cycle. For practical purposes, however, a period of about nine years is acceptable as affording a good determination. A secondary determination may be had from four years or less of observation.

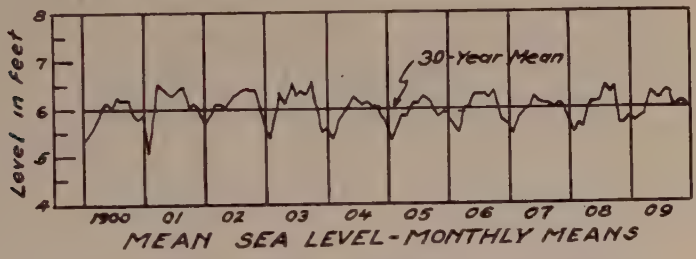

FIG. 1. — FLUCTUATIONS IN MONTHLY MEAN SEA LEVELS, FORT HAMILTON, N. Y., 1900–09

Widespread Occurrence of Periodicity. — These characteristics of the tide curve are noted to occur in very uniform manner over wide areas, as will be seen by reference to Fig. 2.

Subordinate Determinations

It would obviously be impracticable to observe over periods of many years at each point where the determination of local tidal datum planes is required. In view of the regional character of the major factors producing fluctuations, such a process is in fact not necessary. A short record at a subordinate station may be corrected for fluctuations as shown by simultaneous observations at a suitable primary, or control, station where the long-time averages are well determined. It is mainly to furnish this sort of control that long series of observations are being

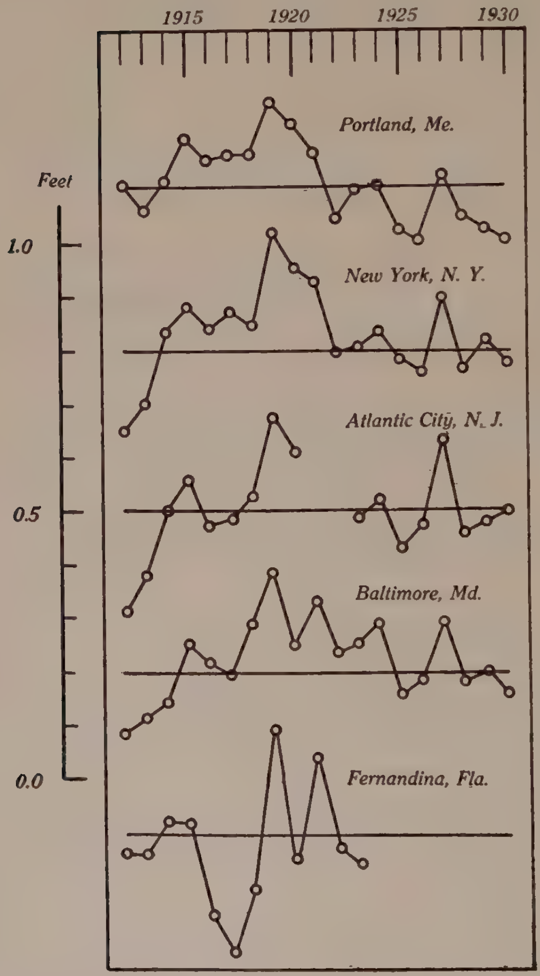

FIG. 2.—COMPARATIVE GRAPHS OF FLUCTUATIONS IN YEARLY MEAN SEA LEVELS AT SEVERAL PRIMARY TIDE STATIONS SUPERIMPOSED ON LONG-PERIOD MEANS. THIS ILLUSTRATES THE WIDESPREAD CHARACTER OF THE FLUCTUATIONS

made by the Coast and Geodetic Survey at many primary stations along the coast.

With such control local datum planes may be determined within 0.1 foot from a month of observation, 0.05 foot after a year, and 0.02 foot after four years.

These considerations are emphasized because of their importance to engineers who may wish to determine local datum planes. It cannot be done with pretensions of accuracy without well-planned and lengthy field observations, except in the immediate vicinity of a control station, and then only during favorable weather.

It is believed that the distribution of tidal bench marks, which will be discussed later, is such that this problem will seldom have to be met by engineers. However, the interest and assistance of the Coast and Geodetic Survey is pledged in the planning of such investigations as may be necessary, and the interpretation of the results.

Characteristics and Uses of Tidal Datum Planes

In the selection of a tidal datum plane to become the basis of a nation-wide datum surface, the degree of uniformity of these planes in extension from place to place became important. It had to be determined how closely they conform to level surfaces. Following is a discussion of their characteristics in this connection.

Mean Sea Level

This hypothetical surface about which the actual water surface oscillates tends to conform to the true level surface that would be generated by faultless spirit levelling. It is, however, subject to the disturbing influences of river run-off, incomplete freedom of water circulation through constricted straits, prevailing winds and abnormal barometic pressures, the dynamic effect of oceanic circulation, etc. This surface therefore has important variations from uniformity in land-locked arms of the sea. Fortunately the variations along the open coast are not of serious practical importance. Except for the inland variations, this approximately level, or equipotential,* surface is nearly ideal as a datum for geodetic levelling, which must be controlled according to connections thereto at coastal points. It is therefore so used.

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* Immaterial to this discussion, but of possible interest, is the fact that an equipotential surface on earth is *not* an ellipsoid or other surface of generation. It varies irregularly from an ellipsoid by important amounts (empirically deduced to be in the order of 60 feet in the western mountain area of the United States). This is due to varied mass and density distribution of the earth's crustal material. The equipotential surface of zero elevation, nearly represented by the mean sea level surface, is the *geoid*, or *true figure of the earth*. A representative ellipsoid is used as a basis for geodetic survey computations.

Variations on the Open Coast. — Permanent variation of local mean sea levels from an equipotential surface is caused along open coasts by certain of the causes stated. It is so slight relative to the distances between points of determination that it is only upon the completion of many lines of carefully adjusted levels that its existence has definitely become known. The variation is slightly greater than the possible levelling errors; nevertheless, for practical reasons, the network is adjusted to zero at reliable points of contact. The elevations of geodetic bench marks over whole coastal regions therefore tend to conform to conditions prevailing over adjacent open ocean regions. It must be noted that careful judgment must be exercised in selecting tide stations to be control points for the geodetic level network. Only primary stations having strong determinations, near the open ocean, and having no suspicion of local variation, are acceptable. The degree of unconformity introduced into the mean sea level datum by adjusting it to fit observed local mean sea levels on open coasts is shown by Table 1.

TABLE 1. — RELATIVE ELEVATIONS OF MEAN SEA LEVEL NEAR OPEN COASTS, BASED ON 1929 SPECIAL ADJUSTMENT OF THE FIRST ORDER LEVEL NET OF THE UNITED STATES

LOCATION	Elevation, in Feet, relative to Boston
Galveston, Tex.	−0.23
Pensacola, Fla.	−0.39
Cedar Keys, Fla.	−0.49
Old Point Comfort, Va.	−1.15
Fort Hamilton, N. Y.	−0.13
BOSTON	0.00
Portland, Me.	+0.16
Halifax, N. S.	+0.03
San Diego, Calif.	+0.85
Seattle, Wash.	+1.35

Variations in Inland Waters. — Local mean sea levels (more properly termed mean *river* levels), determined for navigational or other purposes at inland tidewater ports, such as Hartford or Albany, are found by geodetic levelling to be at higher elevations than on the open ocean. They do not even approximately conform to the level surface defined by ocean mean sea levels. Table 2 illustrates this local variation at a number of ports. The values are fairly representative means, but depend on estimates of what are normal river conditions. Large fluctuations occur as a result of meteorological conditions. It is clear why geodetic levels are not adjusted to coincide with observed mean levels at such places.

TABLE 2. — VARIATIONS BETWEEN LOCAL MEAN RIVER LEVEL AND MEAN SEA LEVEL DATUM AT INLAND PORTS

LOCATION	Mean River Level Above Mean Sea Level Datum, in Feet
Hartford, Connecticut River	2.2
Albany, Hudson River	1.8[1]
Trenton, Delaware River	2.5
Philadelphia, Delaware River	0.8
Wilmington, Cape Fear River	0.6
Jacksonville, St. Johns River	0.4

[1] Value stated for Albany may be somewhat changed, due to recent river improvements.

Variations at Boston. — The geodetic level lines are adjusted approximately to the observed mean sea level at Commonwealth Pier. Even as near by as the Navy Yard, the levelling shows local mean sea level to be 0.11 foot higher. At points in the Mystic River and other headwaters the differences may be greater.

Local Tidal Planes

The other planes in consideration are essentially different from mean sea level in being strictly local in character, although the half tide level does have a marked general similarity to mean sea level.

Half Tide Level. — Use of this plane results from the mathematical simplicity of its determination. Such differences as do exist between this and mean sea level are due to the effect of unsymmetrical tide curves in raising or lowering the mean elevation relative to the halfway mark. The differences are of more interest scientifically than practically, being nearly constant at a given place and generally small along open coasts. Their variations are indicated by Table 3.

TABLE 3. — HEIGHT OF HALF TIDE LEVEL ABOVE MEAN SEA LEVEL

LOCATION	Feet
Portland, Me.	−0.03
New York, N. Y.	−0.05
Atlantic City, N. J.	−0.03
Fernandina, Fla.	−0.10
Seattle, Wash.	+0.01
San Francisco, Calif.	+0.06
San Diego, Calif.	+0.05

Half tide level is subject generally to the same variations affecting local mean sea levels. While local mean sea level may be approximated from half tide level, within the order of accuracy indicated by Table 3, the mean sea level datum may not be so approximated.

Mean Low Water and Mean High Water. — These are so distinctly local in character that they can be said to exist as surfaces of fixed elevation only in the immediate vicinity of points of determination. This is because with differing tidal ranges, noted everywhere, the mean low water plane occurs at various distances below, and the mean high water plane at various heights above, the corresponding local mean sea level. The mean low and mean high water surfaces are warped, their heights above or below local mean sea level being roughly half the range at a given place.

Mean low water is the ideal datum for chart soundings. For instance, a 40-foot sounding on the Boston Harbor chart means that the water is 40 feet deep at the time of mean low water. That the reference surface is warped is of no interest to the mariner. The engineer must remember, however, that mean low and mean high water levels are not usually at the same elevation at different places, even though perhaps near by.

Other uses of the mean low and mean high water planes have obvious importance in the engineering problems of wharf and warehouse construction, drainage and sewage disposal works, determination of bridge underclearances, etc.

Tidal Datum Planes as a Criterion of Coastal Stability.

Tidal datum planes constitute probably the most stable height datum observable by man. They are therefore of interest to scientists in the study of possible emergence or subsidence of coastal lands. Future changes in the relationship of land heights and tidal datum planes will presumably be significant. Unfortunately it is impossible at present to give definite answer to this problem, for tidal observations nowhere have had sufficient duration to afford proof, much less a measure, of so slow a phenomenon.

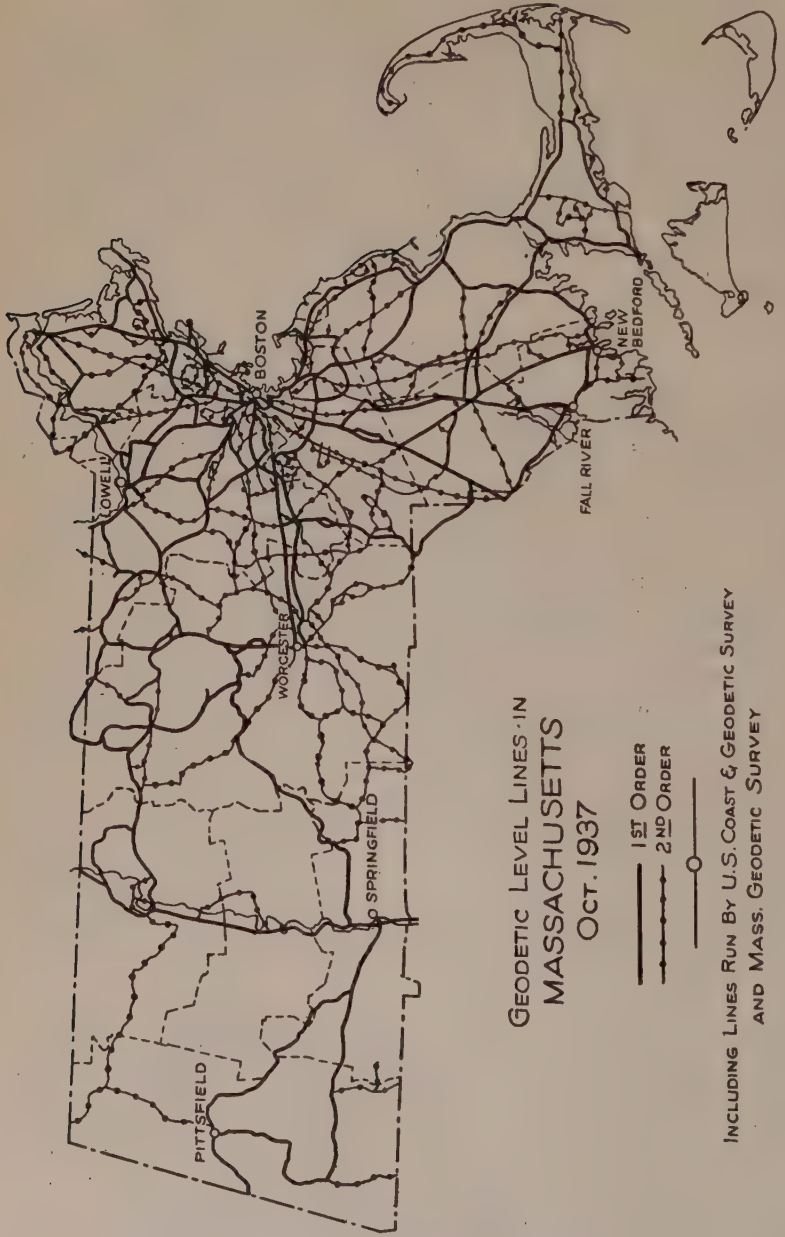
Use of Published Bench Mark Data

Geodetic Bench Marks. — The establishment of a national geodetic datum for surveys is a function of the Coast and Geodetic Survey. First order levelling, based on the mean sea level datum, has been extended, until now, through the efforts of this and other Federal bureaus and state organizations, there is a widespread system of geodetic bench marks. This constitutes a nation-wide frame for the correlation of surveys. In the not too distant future practically every place in the country will be within reasonable access of geodetic bench marks. Fig. 3 shows the lines of geodetic levelling executed in 1937 in Massachusetts.

Tidal Bench Marks. — The Coast and Geodetic Survey has always established local bench marks to reference the datum planes determined by tide observations. These are sometimes but not generally connected to the geodetic system. They exist in very many localities along the coast, making unnecessary in general any reobservation of tides by engineers requiring knowledge of water level conditions, or who need fundamental datums for local use.

Tidal bench marks serve to correlate those special surveys in local areas which have application to water levels. They do not serve to correlate surveys over large areas because the planes to which they refer are of limited extent.

Geodetic and Tidal Bench Marks not Ordinarily Related. — The distinction between these two types of bench marks must be remembered. Tidal bench marks usually have no known relation to the mean sea level datum nor to bench marks of other tide stations. Assumed relations between tidal bench marks of different stations, between tidal bench marks and the mean sea level datum, or between this datum and water levels anywhere are liable to error. Attempts to derive local water level planes from the geodetic datum or *vice versa* should not be made



SKETCH PREPARED BY MASS. GEODETIC SURVEY

Fig. 3. — Geodetic Level Lines in Massachusetts

TABLE 4.

RELATION OF DATUM PLANES IN MASSACHUSETTS: in feet:

Town of Orange--453.52
Town of North Attleboro--171.25
New England Power Assn--105.86
Turners Falls Power Co.---69.26
City of Lowell---55.20
--10.10--Highest known tide, Boston.
Locks and Canals Corp., Lowell----5.20
City of Lawrence----5.08
--4.80--Mean High water, Navy Yard.
--4.58--Mean high water, Comm. Pier.
Town of Framingham----4.06
City of New Bedford---2.55
City of Attleboro---2.26
City of Worcester---0.77
--0.10--Mean sea level, Navy Yard.
U. S. C. & G. S. DATUM ---0.00
--0.01--Mean sea level, Comm. Pier.
Town of Natick--0.04
--0.13--Half tide level, Comm. Pier.
City of Chicopee--0.36
City of Springfield--0.46
Town of Greenfield--0.83
City of Haverhill-1.43
City of Brockton--1.57
Holyoke Water Power Co.--2.53
City of Holyoke--2.60
City of Salem--4.36
Town of Manchester--4.47
City of Peabody--4.82
--4.84--Mean low water, Comm. Pier.
BOSTON LOW WATER DATUM--4.87
--4.91--Mean low water, Navy Yard.
So. Boston Flats base-5.17
City of Lynn--5.29
City of Somerville--5.39
Town of Wellesley--5.50
City of Beverly--5.53
Town of Dedham--5.64
BOSTON CITY BASE--5.65
City of Newton--5.72
Town of Brookline--5.78
City of Quincy--5.82
City of Revere--5.84
City of Everett--5.90
City of Chelsea--6.00
Town of Norwood--6.03
Met. Water Supply Commission-6.049
--8.40--Lowest known tide, Boston.
City of Cambridge-10.84
Town of Walpole--23.28
U. S. Army Engineers-100.35
Boston Navy Yard base--105.08
M.D.C.(sewers)--Town of Needham-105.62

ordinarily. If such attempts cannot be avoided, engineers are urged to avail themselves of the willing advice of the Coast and Geodetic Survey, which may in some cases contribute to the value of the assumptions.

Correlation of Existing Datum Planes

Datum planes of arbitrary origin, which have later been related to tidal datum planes by adequate levelling, become as fixed and forever recoverable as the tidal planes themselves. For this reason the Coast and Geodetic Survey connects its levels to all known level nets encountered. Though such arbitrary datum planes may, for practical reasons, be continued in use on the original basis, their value is vastly increased by the connection. In Boston and vicinity there are numerous such planes, the established relationships of which are shown by Table 4.

Sources of Bench Mark Data

Because of revisions being made in several publications listing bench mark data, they are not referred to by specific name. For descriptions and elevations of all geodetic bench marks on the mean sea level datum in Massachusetts, inquire of Massachusetts Geodetic Survey, 100 Nashua Street, Boston. For descriptions and elevations of tidal bench marks anywhere and geodetic bench marks other than in Massachusetts, inquire of United States Coast and Geodetic Survey, tenth floor, Customhouse, Boston.

References

The following are a few sources of detailed technical information pertinent to the subject. These works contain references to various others.

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"Instructions for Tide Observations." Sp. Pub. 139, United States Coast and Geodetic Survey.

THE BISSORTE DAM SAFETY SPILLWAY

By Martin A. Mason *

Synopsis

The Molare catastrophe in Italy led to additional flood spillway capacity being installed at the Bissorte dam in southeastern France as a safety measure. The design which was adopted for the spillway as a result of model tests represents a new application of the hydraulic jump to spillway use. The addition of a platform below the spillway crest, forming a secondary crest or sill, allows the overflowing water to be collected and directed as desired. For the particular conditions where a tunnel or shaft type spillway would usually be employed, the new design, known as the Danel design, offers certain advantages not found in previous designs.

Bissorte Dam

The Bissorte dam is one of the numerous small dams found in the high Alps of southeastern France forming reservoirs, at high altitudes, to provide water for the operation of the high-head hydroelectric stations which are the source of the majority of the electric power consumed in France. It is located on a tributary of the Arc River in the Vanoise Alps, not far from Modane and the Italian border. Among its many unusual features may be mentioned the following few. Due to its location and the character of the surrounding mountains it was necessary to construct a cableway to carry construction materials from the Arc valley to the dam site. The cableway was later employed in the construction of the penstock, and is now the sole means of reaching the dam, there being no roads to the dam site. Its altitude of 6,500 feet provides a head of 3,500 feet for the turbines located on and discharging into the Arc. The site chosen for the dam is that of a former natural lake which had been almost completely filled with solids carried by the stream, the present 30-meter high dam forming a reservoir in its place. The dam is built of stone blocks cut from the surrounding mountains,

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* John R. Freeman Scholar, Boston Society of Civil Engineers, 1937, at Grenoble, France; on leave from hydraulic laboratory, National Bureau of Standards, Washington, D. C.

and is of the gravity type. Additional storage capacity is provided by a connecting tunnel through the mountain to a small locked valley.

SPILLWAY

Studies prior to the construction of the dam showed that spillway provision against floods of 100 cubic meters per second would be sufficient to protect it from hundred-year floods. Accordingly, four automatic siphon spillways of 30 cubic meters per second capacity, coupled with two emergency sluices of 70 cubic meters per second capacity, were provided for flood protection. However, shortly after the completion of the dam the Molare catastrophe in Italy* caused serious question to be raised as to whether the maximum flood to be expected at Bissorte might not be much larger than had been provided for, as the dam is located only about 100 miles from the Molare site and is subject to the same unusual climatic conditions. It will be recalled that the failure of the Molare dam was caused by an unusual local storm centered about the dam, which resulted in a flood of three times the provided spillway capacity. The fact that climatic conditions and the location of the dam with respect to the surrounding mountains are the same at Bissorte as they were at Molare led to the belief that a similar local storm of great intensity could easily occur at Bissorte.

To prevent the destruction of the dam in the event of the occurrence of such a storm it was decided to add a safety spillway to those already in existence, such spillway to have a capacity of 180 cubic meters per second. It was to be located on a rock spur some 40 meters upstream, on the left end of the dam, and to be placed so as to maintain a freeboard of 1 meter on the dam when discharging at capacity. The level of the new spillway was to be below that of the existing floodways, making it the principal safety device for the dam. Thus there would be provided a total spillway capacity of almost three times the original capacity, this ratio being approximately that of the Molare flood to the predicted maximum.

Because of the topography of the location (Fig. 1) and the character of the rock forming the mountainous sides of the reservoir it was necessary to adopt either a shaft or tunnel type spillway. The by-pass tunnel used in construction, and abutting the dam, being available, it was proposed that the new spillway be designed to use it. Preliminary studies of the rock in the tunnel section and in the rock spur showed it to be satisfactory for the support of a spillway and the necessary connecting tunnel; therefore it was decided to employ a tunnel type spillway, provided model tests showed the design to fulfill all requirements. Final selection of a design was to be based on the results of model tests.

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* Der Bauingenieur, October 11, 1935, & Ann. Ponts & Chaussées, February, 1936.

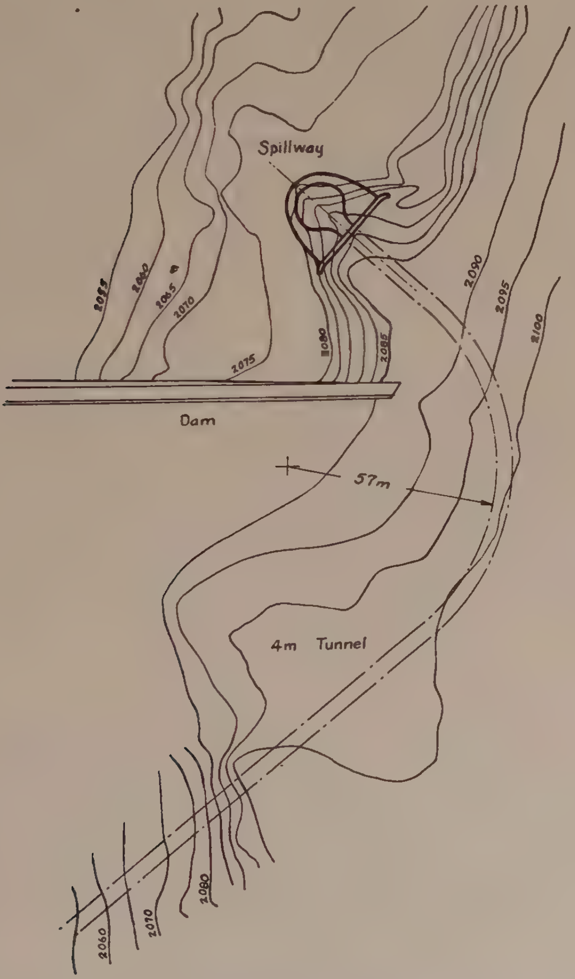

Fig. 1.—Location of Flood Spillway, Bissorte Dam

Conditions to be Met by the Spillway

The following conditions were specified, to be met by any proposed spillway design. The spillway proper was to be located on the previously mentioned rock spur, thus requiring a minimum of masonry foundation for its support. It was to be simple in design and without complicated sections of transition, and be capable of construction from cut stone blocks (as mentioned, stone was available in great abundance, while sand, cement, etc., had to be transported on the cableway). The design likewise was to employ as much of the existing tunnel as possible. Due to the high altitude (6,500 to 7,000 feet) the work was to be capable of rapid execution, as construction could be prosecuted only during the summer months. The water level of the reservoir was not to exceed elevation 2083.0 meters for a maximum discharge of 180 cubic meters per second, providing thus a 1 meter freeboard on the dam; and because of the limited storage capacity the head on the spillway for maximum discharge was not to exceed 1.5 meters. This latter condition therefore automatically located the spillway crest level at 2081.5 meters elevation, if the water level was allowed to reach elevation 2083.0 meters. The existing diversion tunnel which it was desired to use was 4 meters in diameter, of 0.0304 meter per meter slope and discharged into the ravine below the dam at level 2064.0 meters.

In providing safety spillways for dams whose failure may involve loss of life in addition to property loss it is difficult to set a maximum figure for the cost of the safety additions. However, in this case a maximum figure was set by the owners of the dam for the cost of the addition of the spillway. The final condition was, therefore, that the spillway designed should be constructed for the amount stipulated.

TENTATIVE DESIGN

A tentative solution of the problem, employing a tunnel type spillway, was submitted to the hydraulic laboratory of Ateliers Neyret-Beylier & Piccard-Pictet, Grenoble, for study and model tests. The design, proposed by the Société Hydro-électrique de Savoie, owners of the dam, consisted of two crests joined upstream by a concrete wall and divergent downstream, forming the spillway. The downstream faces of the crests were continued to their intersection, forming a triangular basin from which the water was led by a transition section into a short tunnel connecting to the by-pass tunnel. The crests were planned to be located on the rock spur, allowing good use to be made of the naturally level surface of the spur and requiring only a small amount of masonry superstructure for its support. The transition section was composed of straight lines and circular arcs.

Design Proposed by Neyret-Beylier & Piccard-Pictet

Study of the design proposed above led to an alternative design proposed by M. Danel, director of the Neyret-Beylier & Piccard-Pictet laboratory. Having the particular conditions at Bissorte in mind, he proposed a spillway design consisting of a circular or elliptically shaped crest following closely the contour of the spur, and led into the necessary short connecting tunnel by a funnel-shaped basin formed by the spillway downstream faces. In order to develop more thoroughly the details of this alternative design several models of scale 1 to 100 were constructed, and tested with reference to the flow behavior over them. These tests also allowed the evaluation of several considerations with respect to the two designs proposed as solutions.

Preliminary Studies

It was immediately evident that the conditions imposed on the spillway design necessitated a crest form having the highest possible discharge per unit head. This resulted in calculations being made to determine the requisite length of a crest following the well-known Creager profile. The adoption of this shape of crest was not due to fear of the possibilities of damage to the spillway from vibration, but because it is believed that it gives the highest practically possible discharge for a given case of this sort. From the results of numerous previous studies of this type of crest made at the laboratory a coefficient of 0.47 was adopted for use in the general weir discharge formula

$$Q = A\sqrt{2g}\quad L\quad H^{3/2}$$

where $A = 0.47$ = coefficient of discharge. It was then found that the approximate length of crest necessary to discharge 180 cubic meters per second under a head of 1.5 meters was 47 meters. The size of the spur on which the spillway was to be located limited the maximum length of any crest to about 23 meters. For the Société Hydro-électrique de Savoie design this meant that the two crests would each have a length of 23.5 meters, while a semi-elliptical crest plan, allowing a maximum length of crest to be disposed on the spur, would have its minor axis of 23 meters running across the spur and its semi-major axis of 18.5 meters projecting from the mountain along the spur. Therefore either of the proposed designs would be suitable from the standpoint of size.

The next consideration was a study of the capacity of the discharge tunnel to be used for carrying the water around the dam and into the ravine. The original idea had been to use the diversion tunnel, circular in cross-section and 4 meters in diameter, with the lower end at elevation 2064.0 meters. The capacity of this tunnel under optimum conditions was therefore determined. The height of the headwater being limited to a maximum elevation of 2083.0 meters, a total head of 19 meters would be available for carrying the water through the tunnel. However, this would be a maximum value, and since the tunnel when running full could not utilize the full 19 meters, calculations were made of the velocity obtainable under a head of 15 meters, representing approximately the condition of the tunnel running full. The corresponding entrance velocity of the water was found as 17 meters per second and for the slope of the tunnel as planned the mean velocity would be about 15 meters per second. The area of the passage being 12.6 square meters, its capacity is 189 cubic meters per second; therefore it would be sufficiently large under optimum conditions.

The performance of the Danel design as shown by the preliminary studies was so satisfactory that further tests were made on a larger scale model in order to arrive at a final design.

MODEL TESTS

Models were built of concrete according to both designs under test. The model of the Société Hydro-électrique de Savoie design was tested to determine the flow behavior over it without completely modeling the mountain side and spur, as it was suspected that the flow behavior would not be satisfactory.

The Danel design was modeled at the same scale, 1 to 30, as the Société Hydro-électrique de Savoie design, and disposed on a similarly scaled exact reproduction of the rock spur, in the position it would occupy in the prototype. Iron wires bent to the form of the rock contours at different levels served as guides for the construction of the spur and mountain side. The model discharge tunnel, with a small section of the top cut away, allowed observation of the flow behavior in the tunnel.

The scale of the models was chosen so that the thickness of the overflowing sheet would be great enough, for the conditions of maximum discharge, to eliminate question as to the effect of surface tension on the results. The structures were built of concrete, as it was desired that the models be permanent.

The arrangement of the model of the tentative Société Hydro-électrique de Savoie design is shown in Fig. 2. Test showed that even at very low heads, corresponding to discharges far below the required maximum, the flow in the collecting basin and tunnel entrance was very turbulent, making it impossible to pass the required discharge through the 4-meter diversion tunnel. Further tests of this design were therefore abandoned.

The arrangement of the model for the Danel design was as follows. The model having been constructed as noted previously, a stilling basin was built surrounding the spillway. Water was supplied to the basin by a small centrifugal pump through a supply pipe leading to the basin. In the basin was fitted a perforated steel plate concentric with the spillway crest, thereby serving to dissipate any velocity head existing in the basin. The flow to the model was measured by a Venturi meter installed

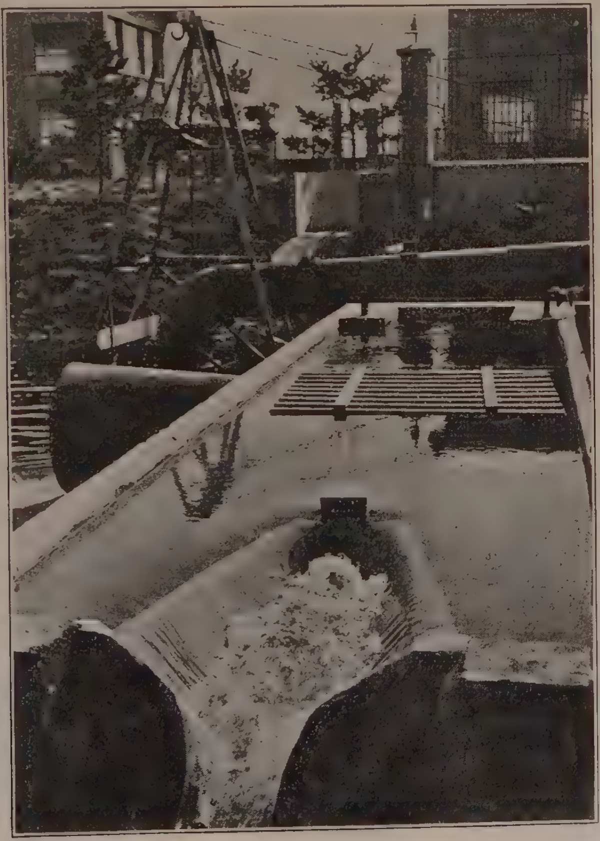

FIG. 2.—MODEL OF SOCIÉTÉ HYDRO-ÉLECTRIQUE DE SAVOIE—TENTATIVE DESIGN

in the supply line. The meter had not been calibrated at the time of the tests, and an approximate coefficient of 0.98 was adopted for it; later results indicated, however, that small errors from this source would not be of significance in the final result.

First, tests were made of the design with the transition section to the tunnel formed by the spillway sides extended from Creager's profile, on a radius corresponding to 7.3 meters for the prototype, to their intersection with the bed of the tunnel, forming thus a basin of half-funnel shape. With this design the flow on the spillway faces was quite satisfactory, being stable and with no separation from the face indicated. However, at the confluence of the funnel a high, narrow jet was formed by the discharging water. The jet was very unstable and wavered in and out of the tunnel entrance at random, resulting in a region of high turbulence at this point.

The design was then modified by changes in the upper portions of the spillway downstream faces, these portions being the critical sections which govern the form of the jet. Mixing or transition basins of both triangular and trapezoidal form were tested in an effort to find a form which would mold a jet of approximately the shape and size of the tunnel entrance, and yet would not be characterized by a large head loss. These tests resulted at length in the final design.

Final Spillway Design and Tests

In this design a flat, almost level platform is placed on the forward half of the semi-ellipse formed by the crest, and is located just below the crest. The platform in turn is joined to the tunnel entrance by a channel of almost perpendicular slope, intersecting the spillway side walls extended as before from Creager's profile, and connected to both the bed of the tunnel and the platform by circular arcs. (Figs. 3 and 4.) The spillway was thus composed of two sections: one, the crest over the entire semi-ellipse; and two, the flat platform of small slope below the forward half of the crest, forming at its intersection with the steep channel leading to the tunnel a secondary sill or crest. The function of the platform is to act as a collecting basin wherein the discharge from the forward portion of the crest may be collected and then redirected by the connecting channel of steep slope into the tunnel entrance.

Tests of this design showed a good performance in every respect. The flow on the platform was characterized by a standing wave just upstream of the secondary sill (Fig. 6), the flow over the sill then being directed toward the tunnel entrance and meeting the flow from the

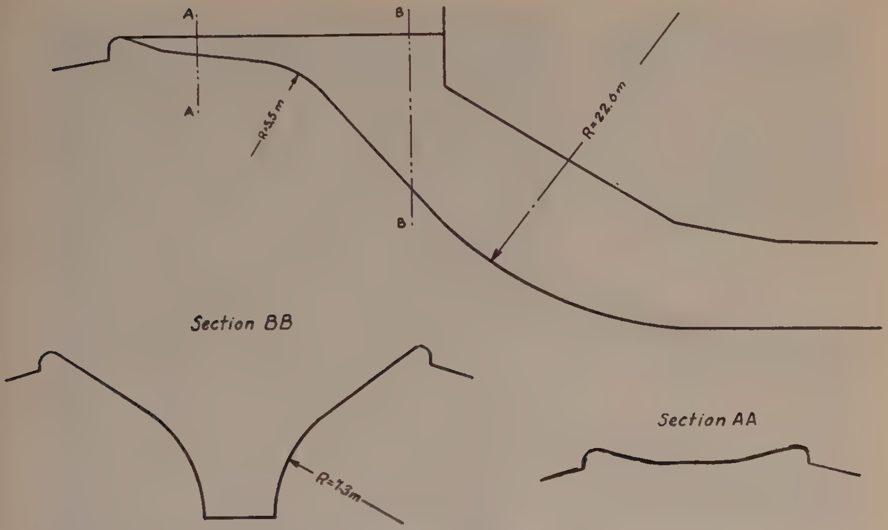

FIG. 3. — DANEL SPILLWAY — GENERAL ARRANGEMENT

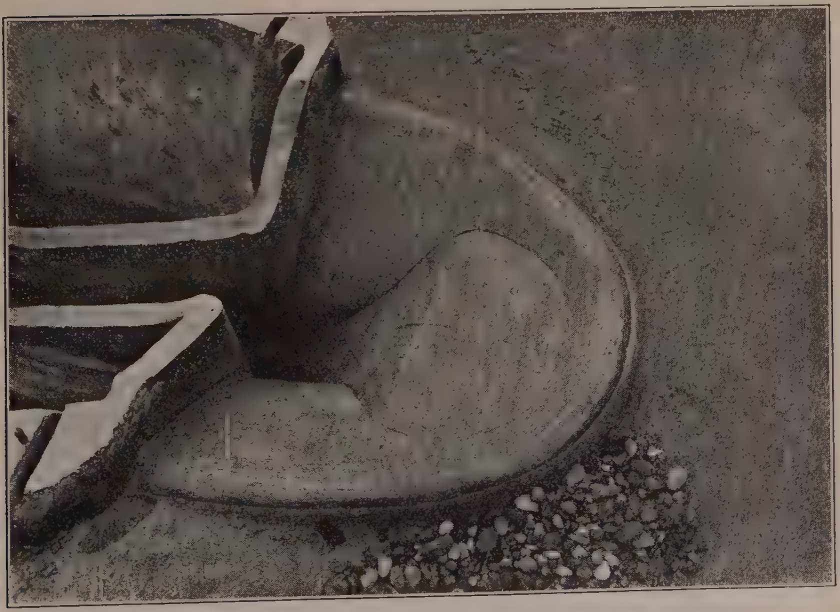

FIG. 4. — MODEL AT 1 TO 30 SCALE OF DANEL SPILLWAY

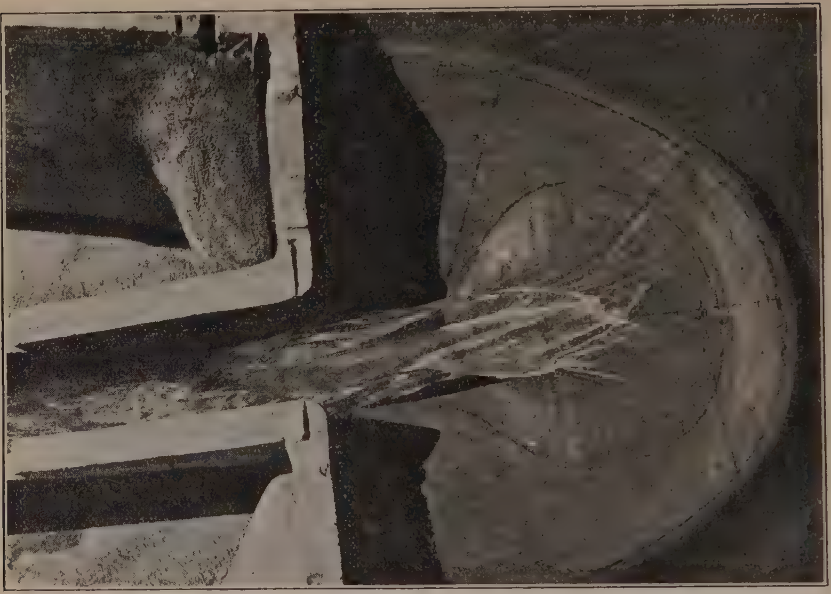

FIG. 5. — DANEL SPILLWAY OPERATING AT MAXIMUM REQUIRED DISCHARGE

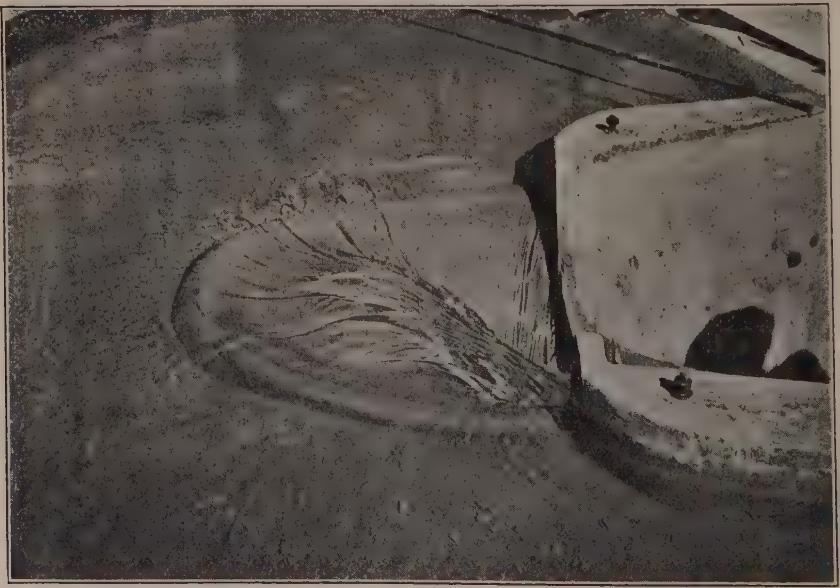

FIG. 6. — STANDING WAVE ON DANEL SPILLWAY MODEL

side walls in such a manner as to form a jet entering directly into the tunnel entrance with no appreciable disturbance.

A study of the effect on the flow behavior of obstructions placed on the platform and crest showed practically no change in the behavior, the flow being stable under all conditions. For instance, the only change induced by an obstruction placed on the platform, representative of a log or ice jam there, was a change of the standing wave to a jump, however, unaccompanied by any change in the shape or size of the jet. As was expected from the preliminary studies it was found that when passing the required discharge the tunnel was only partially filled; that is, conditions of "shooting" flow with a free surface existed. No tests were made to determine the maximum capacity of the spillway, since it was felt these figures would be valueless because of the uncertainty attaching to their transfer to the prototype as a result of the unknown effect of the comparative roughness of the model and prototype.

It was found that by changing the position of the secondary sill relative to the tunnel entrance jets of various shapes and sizes could be obtained. Thus for any given set of conditions it was possible to adjust the geometry of the jet within quite wide limits. For a particular case the secondary sill is, of course, located so as to obtain optimum performance for the maximum flow expected. The flexibility afforded by this feature allows considerable freedom in the design of the accompanying tunnel, so that, in general, both the spillway and the tunnel can be designed to take advantage of the best conditions offered each at any given site.

A discharge curve for the final Danel design is shown on Fig. 7.

COMPARISON OF DESIGNS

A comparison was made of the Société Hydro-électrique de Savoie and Danel designs both from the standpoint of hydraulic performance and relative cost of construction. In performance the latter design was shown by test to be very much superior, the excellent flow conditions obtained permitting the use of the existing diversion tunnel, which was actually of greater capacity than was required under the conditions obtaining. Comparison of construction requirements showed a probable saving of 700 cubic meters of masonry and 200 cubic meters of excavation by the use of the Danel design.

Complete justification for the use of the Danel design did not, however, exist without a comparison being made of the relative cost and performance of a shaft type spillway. For a study of performance a representative shaft spillway, on which model tests had been made,* was selected, and the relative discharges compared on a common basis of unit length of crest. Several advantages of the Danel design were immediately apparent. Primarily, it is not subject to the formation of the so-called "mushrooms" of water attendant on all vertical shaft spillways. Likewise, since the tunnel entrance is the determining factor in regulating the spillway jet shape and size, so that the jet exactly enters into the tunnel with no disturbance, there is no important problem as to entrained air. For the Bissorte site a shaft type spillway would be very much more expensive to construct than the tunnel type, because of its larger required size and the greater amount of excavation required for its construction.

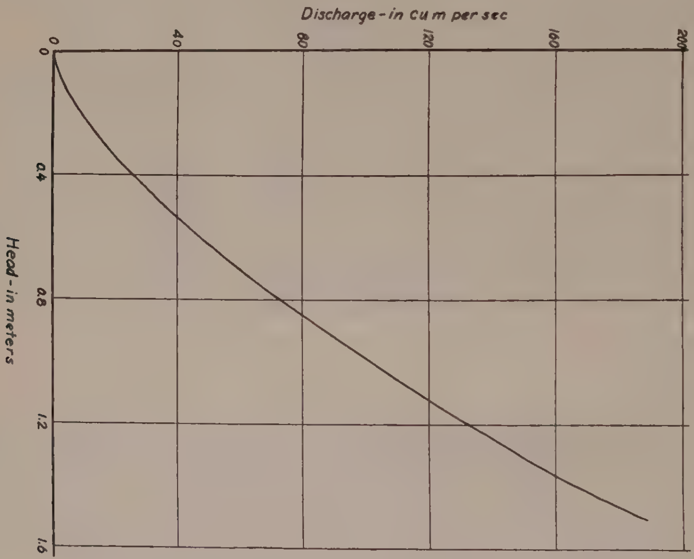

FIG. 7. — DISCHARGE CURVE OF BISSORTE FLOOD SPILLWAY

CONCLUSION

The Danel spillway design is of interest for those cases where a tunnel spillway is indicated by the natural conditions at the dam site. The flexibility of design afforded by the adjustment of the secondary sill position permits the utilization of the best features of any site with regard to tunnel and spillway location or disposition. The economical use of the design is, however, limited to those cases in which a tunnel or shaft type spillway would ordinarily be employed, and in which a promontory or spur is available for the support of the crest and platform.

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* "The Hydraulic Design of the Shaft Spillway for the Davis Bridge Dam." Transactions, American Society of Civil Engineers, Vol. LXXXVIII, 1925.

Acknowledgment

Acknowledgment is made to the Société Hydro-électrique de Savoie, owners of the Bissorte dam, and to M. Pierre Danel, director of research, Ateliers Neyret-Beylier & Piccard-Pictet, Grenoble, for their permission to publish the information contained herein.

OF GENERAL INTEREST

PRIZES AWARDED AT ANNUAL MEETING ON MARCH 16, 1938

The Desmond FitzGerald Medal

TO DONALD W. TAYLOR, MEMBER

Presentation made by Prof. Albert Haertlein, Chairman of Committee on Award

The Desmond FitzGerald Medal was instituted and endowed in 1910 by the late Desmond FitzGerald, a Past President and honorary member of this Society, and is awarded annually for a paper presented to the Society by a member, and published during the year, which is adjudged worthy of special commendation for its merit. The Committee on Award this year, consisting of Prof. Albert Haertlein, Frank E. Winsor and Charles J. O'Donnell, selected from the list of a number of excellent papers one which was recommended to the Board of Government for the award. The paper selected was entitled "Stability of Earth Slopes," by Donald W. Taylor, member, presented at a joint meeting of the Designers and Highway Sections held on November 23, 1937, and published in the JOURNAL of the Society, July, 1937. On behalf of the Board of Government Professor Haertlein presented the Desmond FitzGerald Medal to Mr. Taylor. Mr. Taylor expressed his appreciation of the honor bestowed upon him by the presentation of this medal.

The Sanitary Section Prize

TO ROBERT SPURR WESTON, MEMBER

Presentation by Past President Frank E. Winsor, Chairman of Committee on Sanitary Section Prize Award

On behalf of the Board of Government, Past President Frank E. Winsor, Chairman of the Committee on Prize Awards, presented the prize to Robert Spurr Weston, member, for his paper entitled "The Treatment of Wool Scouring Waste," presented at a meeting of the Sanitary Section held on April 7, 1937, and published in the July, 1937, JOURNAL. The prize consisted of books: "American Sewerage Practice, Volume III, Disposal of Sewage," by Metcalf & Eddy; "Elimination of Taste and Odor in Water," by John R. Baylis; and Mannings Formula Table. Mr. Weston accepted the prize with appropriate remarks.

The Designers Section Prize

To John B. Wilbur, Member

Presentation by Prof. Albert Haertlein, Chairman of Committee on Designers Section Prize Award

On behalf of the Board of Government, Prof. Albert Haertlein, Chairman of the Committee on the Designers Section Prize Award, presented the Designers Section Prize to Prof. John B. Wilbur, member, for his paper entitled "Model Analysis of Structures," presented at a meeting of the Designers Section held on December 8, 1937, and published in the January, 1938, Journal. The prize consisted of books: "Theory of Elastic Stability," by S. Timoshenko, and "Theory of Elasticity," by R. Southwell. Professor Wilbur accepted the prize with appropriate remarks.

The Clemens Herschel Prize

To Charles M. Noble

Award presented by Past President John B. Babcock, 3d

The Clemens Herschel prize was established by a gift from the late Clemens Herschel, a Past President and honorary member of the Society, and is awarded for a paper which has been particularly useful and commendable and worthy of recognition. This year the prize was awarded to Charles M. Noble for his paper on "The Factor of Safety in Highway Design," presented at a meeting of the Society held on January 27, 1937, and published in the April, 1937, Journal. On behalf of the Board of Government, Past President John B. Babcock presented the prize, which consisted of a book, "The Water Supply of the City of Rome," by Clemens Herschel. Mr. Noble accepted the prize with appropriate remarks.

PROCEEDINGS OF THE SOCIETY

MINUTES OF MEETINGS

Boston Society of Civil Engineers

January 26, 1938. — A regular meeting of the Boston Society of Civil Engineers was held this evening at the Engineers' Club and was called to order at 7 p.m. by Vice President Karl R. Kennison. Sixty-eight members and guests attended the meeting. Fifty-eight persons attended the buffet supper.

Announcement was made of the election of the following new members on January 26, 1938:

Grade of Student: Joseph J. Caruso, Charles A. de Luccia.

Vice President Kennison stated that at the last meeting (December 16, 1937) a vote was passed regarding the use of the current income of the Permanent Fund. A similar vote, final action, is necessary at this meeting.

Voted, That the Board of Government be authorized to use as much of the current income of the Permanent Fund as is necessary to meet the current expenses of the Society.

Vice President Kennison then introduced the speaker of the evening, Dr. Thorndike Saville, Dean of the College of Engineering, New York University, New York City, who gave a very interesting address on "Control of Interstate Stream Pollution."

Informal discussion and a question period followed the address.

The meeting adjourned at 9 P.M.

EVERETT N. HUTCHINS, *Secretary.*

FEBRUARY 16, 1938. — A regular meeting of the Boston Society of Civil Engineers was held this evening at the Engineers' Club and was called to order by the President, Arthur D. Weston. Sixty members and guests were present. Fifty persons attended the supper.

The Secretary reported the election of new members on February 16, 1938, as follows:

Grade of Member: Robert M. Becker, Joseph F. Cavazzoni, Ernest L. F. Davis, Edwin S. Rich.

Grade of Junior: David Mayer, Lester S. Perry.

The President then introduced the speaker of the evening, Mr. Roland B. Greeley, Research Assistant, National Resources Committee, District No. 1, Boston, Massachusetts, who gave a very interesting talk on "Planning for New England as a Whole." The talk was illustrated with lantern slides.

The meeting adjourned at 8.15 P.M.

EVERETT N. HUTCHINS, *Secretary.*

MARCH 16, 1938. — The ninetieth annual meeting of the Boston Society of Civil Engineers was held today at the Boston Chamber of Commerce, and was called to order at 4.30 P.M. by the President, Arthur D. Weston.

The minutes of all previous meetings of the year which have been printed in the various issues of the JOURNAL were approved as printed.

The Secretary reported the election of the following new members:

Grade of Student: Adam M. Cook, Lloyd P. Crumb, John J. Gill, Walter T. Grady, Charles G. Hunt, Jr., Gardner H. Lewis.

The annual reports of the Board of Government, Treasurer, Secretary and Auditors were presented. Reports were also made by the following committees: Social Activities, Relation of Sections to Main Society, Welfare, Library, 1936 Floods, and John R. Freeman Fund.

Voted, That the reports be accepted with thanks and placed on file, and that they be printed in the April, 1938, JOURNAL.

Voted, That the incoming Board of Government be authorized to appoint such committees as it deems desirable.

The report of the Tellers of Election, Arthur B. Appleton and Edward S. Averell, was presented, and in accordance therewith the President declared the following had been elected officers for the ensuing year:

President — Karl R. Kennison.
Vice President (for two years) — Frank B. Walker.
Secretary — Everett N. Hutchins.
Treasurer — Charles R. Main.
Directors (for two years) — S. Stanley Kent, Frederic N. Weaver.
Members of Nominating Committee (for two years) — Alexander J. Bone, Frank L. Flood, Waldo F. Pike.

The retiring President then delivered his annual address on "Charles River Basin."

Seventy members attended this part of the meeting.

The meeting adjourned to assemble at 7.30 P.M., the annual dinner being held during the interim. A music and singing program was provided during the dinner period.

The President then called the meeting to order for the presentation of prizes.

The President called upon Prof. Albert Haertlein, Chairman of the Committee on Award of the Desmond FitzGerald Prize, to present this prize to Donald W. Taylor, member, for his paper entitled "Stability of Earth Slopes," presented at a joint meeting of the Designers and Highway Sections held on November 23, 1937, and published in the July, 1937, JOURNAL.

Past President Frank E. Winsor, Chairman of the Sanitary Section Prize Award Committee, presented the Sanitary Section Prize to Robert Spurr Weston, member, for his paper on "The Treatment of Wool Scouring Wastes," presented at a meeting of the Sanitary Section held on April 7, 1937, and published in the July, 1937, JOURNAL. The prize consisted of the books, "American Sewerage Practice, Volume III, Disposal of Sewage," by Metcalf & Eddy; "Elimination of Taste and Odor in Water," by John R. Baylis; and Manning's Formula Table.

Professor Haertlein, as Chairman of the Designers Section Prize Award Committee, presented the Designers Section Prize to Prof. John B. Wilbur, member, for his paper on "Model Analysis of Structures," presented at a meeting of the Designers Section held on December 5, 1937, and published in the January, 1938, JOURNAL. The prize consisted of the books "Theory of Elastic Stability," by S. Timoshenko, and "Theory of Elasticity," by R. Southwell.

Past President John B. Babcock, 3d, made the presentation of the Clemens Herschel Prize to Charles M. Noble for his paper on "The Factor of Safety in Highway Design," presented at a meeting of the Society held on January 27, 1937, and published in the April, 1937, JOURNAL. The prize consisted of the book, "The Water Supply of the City of Rome," by the late Clemens Herschel.

The newly elected President, Karl R. Kennison, and other distinguished guests were introduced.

President Weston then introduced the guest speaker, Col. Willard T. Chevalier, Vice President, McGraw Hill Publishing Company, Inc., who gave a very interesting talk on "The Engineer and Modern Trends."

One hundred and thirty-eight members and guests attended the dinner.

The meeting adjourned at 9.45 o'clock.

EVERETT N. HUTCHINS, *Secretary.*

Sanitary Section

NOVEMBER 3, 1937. — A special meeting of the Sanitary Section was held jointly this evening with the American Society of Civil Engineers, Northeastern Section, at Pierce Hall, Oxford Street, Cambridge, after a dinner at the Harvard Faculty Club.

The speaker was Mr. William Firth Wells of the University of Pennsylvania, formerly of the Harvard Graduate School of Engineering and School of Public Health. His subject was "Light on Air-Borne Infection — A New Problem for the Engineer."

There were 26 present at the dinner and 40 persons attended the meeting.

RALPH M. SOULE, *Clerk.*

FEBRUARY 2, 1938. — A special meeting of the Sanitary Section was held on this date. Dinner was enjoyed at Patten's Restaurant, Court Street, and the meeting was called to order at 7.15 P.M. in the Society rooms by Chairman Richard S. Holmgren. A nominating committee was chosen to present nominations for officers to be elected at the annual meeting. Ralph M. Soule presented a paper on the "Sanitation of Trailer Camps." The discussion was led by Mr. John Hanagan, Inspector of the New Hampshire State Board of Health. The meeting adjourned at 8.20 P.M.

RALPH M. SOULE, *Clerk.*

MARCH 2, 1938. — The annual meeting of the Sanitary Section was held this evening. Preceding the meeting, 24 members gathered at Patten's Restaurant for dinner.

The meeting was called to order by the Chairman, Richard S. Holmgren, at 7.05 P.M., with 33 members and guests present.

The report of the Executive Committee for the past year was read and accepted.

The report of the Nominating Committee for officers for the coming year was submitted as follows:

Chairman — Samuel M. Ellsworth.
Vice Chairman — Gail P. Edwards.

Clerk — Ralph M. Soule.
Executive Committee — Richard S. Holmgren, Samuel T. Drew, Edwin B. Cobb.

No further nominations were made, and it was —

Voted, That the clerk cast one ballot for the election of these officers.

Two possible trips for a June outing were placed before the Section for a vote as to which would be more desirable, namely, a trip to the Massachusetts Military Reservation in Sandwich or a trip to Newburyport and vicinity to see the waterworks treatment plant, the clam treatment plant and possibly other items of interest. The majority voting favored the trip to Sandwich.

Mr. F. W. Gilcreas of the New York State Department of Health presented a very interesting paper on "A Co-operative Laboratory and Engineering Program for the Control of Public Water Supplies in New York State." Much interest was shown in this paper, as evidenced by the lengthy discussion which followed.

The meeting adjourned at 9.15 P.M.

Respectfully submitted,

RALPH M. SOULE, *Clerk.*

Designers Section

JANUARY 12, 1938. — A regular meeting of the Designers Section was held this evening at the Society rooms and was called to order by the chairman at 6.30 P.M.

The speaker of the evening was Mr. Fredrick H. Crabtree of Tufts College. His talk was entitled "An Engineer Looks at Geology," and dealt with the reasons for the variations in shore lines of rivers and harbors. Mr. Crabtree has had occasion to travel over many parts of the United States, and discussed the above problem as related to the Mississippi River, the Columbia River, Chesapeake Bay, Boston Harbor and other waterways in various sections of the country.

The talk was illustrated by lantern slides.

The meeting adjourned at 8 P.M. The attendance was 45.

J. D. MITSCH, *Clerk.*

FEBRUARY 9, 1938. — A regular meeting of the Designers Section was held at the Society rooms this evening, and was called to order at 6.30 P.M. The clerk's report of the January meeting was read and approved.

The Chairman called for nominations for new officers to be elected at the March meeting. It was moved and seconded that the Chairman appoint a committee of three to act as a Nominating Committee and submit a list of nominees at the next meeting.

The motion was passed and the Chairman appointed the following members to the committee:

Prof. Albert Haertlein.
Prof. Frederick Weaver.
Mr. Henry Brask.

The speakers of the meeting were Prof. Robinson Abbott of Tufts College and Mr. Albert Kleinert of the Massachusetts Department of Public Works. The subject was "The Development of Highway Bridges During the Last Ten Years."

The talks were illustrated with lantern slides.

The meeting closed at 8.50 P.M., and the attendance was 54.

J. D. MITSCH, *Clerk.*

MARCH 9, 1938. — The annual meeting of the Designers Section was held this evening at the Society rooms, at 6.30 P.M. The secretary's report of the February meeting was read and approved.

This being the annual meeting, the report of the Executive Committee was read and approved.

The Nominating Committee then presented its nominations for officers for the new year. Further nominations were called for from the floor. It was moved and seconded that nominations be closed, and that the Secretary be instructed to cast one ballot for the nominees presented by the Nominating Committee. The motion was passed unanimously, resulting in the election of the following officers:

Chairman — Anthony S. Combs.
Vice Chairman — John D. Mitsch.

Clerk — Kimball R. Garland.
Executive Committee — Robinson Abbott, Arthur Casagrande, Albert Kleinert.

The speaker of the evening, Mr. Maurice A. Reidy, consulting engineer of Boston, was then introduced. He spoke on the subject of "Structural Problems Met in the Alterations to Buildings" and explained in detail the alterations of the Henry Seigel Building on Washington Street, Boston.

The talk was illustrated with slides.

The attendance was 48 and the meeting adjourned at 9 P.M.

J. D. MITSCH, *Clerk*.

Highway Section

OCTOBER 27, 1937. — A regular meeting of the Highway Section of the Boston Society of Civil Engineers was held in the Society rooms, 715 Tremont Temple, this evening. The meeting was called to order at 7.15 P.M. by the Chairman, Prof. A. J. Bone.

There was no business to come before the meeting, and the Chairman gave a brief account of the April 24 meeting, thus dispensing with the reading of the minutes.

The Chairman then introduced the speaker of the evening, Mr. John V. McManmon of the Massachusetts Department of Public Works, who spoke on the subject of "Roadside Development." The speaker explained that when possible this work is carried on in co-operation with the construction of the road itself, such as on the present Newburyport Turnpike project. Its purpose is to stabilize slopes and retain a natural appearance on all disturbed earth surfaces by such planting as will blend with the surrounding country. Moving pictures were shown to present a clearer aspect as to how the work is being carried out. Of particular interest were the pictures of the various stages of work on an existing high, side-hill cut in the town of Palmer. This slope had a very poor appearance, and considerable trouble was encountered in maintaining it before development.

After the speaker completed his talk there was a discussion period.

The speaker was accorded a rising vote of thanks and the meeting adjourned at 8.30 P.M., with an attendance of 17 members.

THOMAS G. GIBLIN, *Clerk*.

NOVEMBER 23, 1937. — A regular meeting of the Highway Section of the Boston Society of Civil Engineers was held in conjunction with the Designers Section this evening. The meeting was called to order at 6.45 P.M. by Mr. Herman G Dresser, Chairman of the Designers Section.

There was no business to come before the meeting, and the Chairman dispensed with the reading of the minutes of both Sections until some future time.

The Chairman then introduced the speaker of the evening, Mr. Donald W. Taylor, Research Associate in Soil Mechanics, Massachusetts Institute of Technology, who presented a paper on the "Stability of Earth Slopes." The speaker explained the method used to determine the stresses in an earth slope, illustrating his talk with slides and pictures. Of interest to the Highway Section were the pictures of two recent failures of roadways due to shifting of slopes. This paper has been printed in full in the July, 1937, issue of the JOURNAL.

After the speaker completed his talk there was a discussion period.

The speaker was accorded a rising vote of thanks, and the meeting adjourned at 7.55 P.M., with an attendance of 40 members.

THOMAS G. GIBLIN, *Clerk*.

FEBRUARY 23, 1938. — The annual meeting of the Highway Section of the Boston Society of Civil Engineers was held in the Society rooms, 715 Tremont Temple, on the evening of Wednesday, February 23, 1938. The meeting was called to order at 7.10 P.M. by the Chairman, Prof. A. J. Bone.

The Chairman called for the minutes of the meeting held on November 23, 1937, which were read and approved. He then called for the report of the Executive Committee which was also read and approved.

The Chairman next called for a report from the Nominating Committee. Prof. Henry B. Alvord, Chairman of the Committee, presented the following names as officers for the coming year:

Chairman — Thomas Coleman, Massachusetts Department of Public Works.
Vice Chairman — Thomas Giblin, Massachusetts Department of Public Works.
Clerk — A. E. Harding, Simpson Brothers Corporation.
Members of the Executive Committee — Prof. A. J. Bone, Massachusetts Institute of Technology; Donald W. Taylor, Research Associate in Soil Mechanics, Massachusetts Institute of Technology. L. J. Wertheim, Standard Oil Company, Park Square Building, Boston.

The report of the Committee was accepted and the clerk instructed to cast one ballot for the candidates named.

The Chairman introduced the speaker of the evening, Mr. J. E. Lawrence, Maintenance Engineer, Massachusetts Department of Public Works, who spoke on the subject of "Modern Methods of Maintenance and Betterments." Mr. Lawrence described this work of the State Maintenance Department on the highways. He explained the process used to make some of the highways more skid proof, using a treatment of bitumen. He stated that where possible, provision is being made for stopping areas along existing highways, which can be used for changing a tire, etc. Of interest is the fact that space is being provided, in the abutments of some of the new bridges and overpasses, for snowplows and other maintenance equipment, so that it will be quickly available when needed.

After the speaker completed his talk there was a discussion period which lasted for fifteen minutes.

The speaker was accorded a rising vote of thanks, and the meeting adjourned at 7.50 P.M., with an attendance of 28 members.

Thomas G. Giblin, *Clerk.*

Northeastern University Section

March 24, 1938. — The annual election of officers of the Section was held at a special meeting on this date.

A Nominating Committee, comprising the Executive Committee of the Section, selected several candidates, and further names were added from the floor.

The result of the election was as follows:

Chairman — N. B. Cleveland.
Clerk — A. B. Davis.
Executive Committee — R. Manning and Joseph Higgins.

Harold E. Sanford, *Clerk.*

March 10, 1938. — An interesting supper meeting of the Northeastern University Section was held in the new dining hall of the Young Men's Christian Association this evening.

The speaker of the evening, Mr. Leslie Williams, Research Associate of the Street Traffic Bureau of Harvard University, spoke on the subject, "Traffic Engineering." After the talk an open discussion was held. The meeting adjourned at 9.30 P.M.

Harold E. Sanford, *Clerk.*

APPLICATIONS FOR MEMBERSHIP

[March 20, 1938]

The By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of fifteen (15) days from the date given.

For Admission

Curtis, Alanson Robert, Concord, N. H. (Age 30, b. Medford, Mass.) Graduated from Colby College, 1931, with S.B. degree. May, 1932, with Massachusetts Department of Public Works as junior chemist in charge of physical and chemical testing of bituminous materials; then included supervision of bituminous concrete plant inspection, general advisory activities in the field in connection with the use of bituminous materials in road construction, and assisted in the writing of department specifications, particularly with reference to bituminous construction. In 1937 passed examination for assistant civil engineer, Grade IV, Massachusetts Department of Public Works. March 22, 1937, to date, as sales engineer in asphalt division, Colonial Beacon Oil Company, promoting use of asphalt and supervising construction involving its use. Refers to *A. B. Appleton, R. W. Coburn, George H. Delano, E. N. Hutchins, J. E. Lawrence.*

For Transfer from Grade of Junior

Burke, Lawrence S., Milton, Mass. (Age 28, b. Providence, R. I.) Attended Mechanic Arts High School; Wentworth Institute Day Course in Architectural Construction, two years; evening course at Franklin Union in bridge design, one year, and reinforced concrete design, one year; MacFarlane & Abbott, Boston, two months (1929) as electrical draftsman; Cleverdon, Varney & Pike, Consulting Engineers, 1929 to 1934, as structural draftsman and designer in steel, concrete and wood; Metcalf and Eddy, Engineers, January, 1934, to May, 1935, steel and concrete design and detail; E. B. Badger & Sons, May, 1935, to August, 1935, as concrete designer; August, 1935, to December, 1935, with Coolidge, Shepley, Bulfinch & Abbott, Architects, as structural engineer; December, 1935, to present time, as structural designer, detailer and checker; and at present with E. B. Badger & Sons Company, Oil Refining and Chemical Engineers (except for two months with Aberthaw Company, Contractors), as structural engineer on industrial chemical plants and oil refining plants. Refers to *H. G. Dresser, LeRoy M. Hersum, W. F. Pike, A. L. Shaw, E. A. Varney.*

Fitzgerald, William H., Boston, Mass. (Age 28, b. Medford, Mass.) Graduated from Boston English High School and Northeastern University, receiving degrees B.C.E. in 1931 and B.S. in civil engineering in 1932. While at Northeastern University, co-operative periods, was rodman with John E. Rand, Melrose, G. W. Cutting, Jr., Weston, and transitman and inspector of sewer construction with city of Waltham, and as draftsman with assessing department, city of Boston; after graduation, with assessing department, city of Boston, until 1934, as draftsman and supervisor of draftsmen; during 1935 and 1936 engaged in miscellaneous surveying and engineering work; 1937 to date, as an engineer and chief of party on Commonwealth Avenue Underpass for Transit Department, city of Boston, a W. P. A. project. Refers to *H. B. Alvord, C. O. Baird, Jr., L. M. Clark, J. W. Greenleaf, Jr., A. A. Minichiello.*

McCarthy, James Anthony, Quincy, Mass. (Age 31, b. Revere, Mass.) Was graduated from Massachusetts Institute of Technology, 1928, in civil engineering; graduate study, 1929. June to September, 1927, engineer with Bay State Dredging and Contracting Company, Boston; June, 1928, to June, 1929, assistant in civil engineering, Massachusetts Institute of Technology; June to September, 1929, structural engineer, Berliner-Joyce Aircroft Corporation, Baltimore, Md.; September, 1929, to November, 1930, engineer, Bridge Department, Boston & Maine Railroad, Boston; November, 1930, to April, 1933, superintendent of design and construction of fuel oil engines, Palmer Inventions, Inc., Boston; January to April, 1934, assistant engineer, Fay, Spofford & Thorndike, Boston; August, 1934, to April, 1935, mathematician, United States Coast and Geodetic Survey, Pennsylvania, New York, Maryland, Virginia, Connecticut, Massachusetts; July to October, 1935, chief of party, Blackstone River Flood Control Survey, Uxbridge, Mass.; October, 1935, to October, 1936, structural engineer with Megquer-Jones Steel Company, Portland, Maine; February, 1936, to February, 1938, assistant engineer, Fay, Spofford & Thorndike, Engineers, Boston; February, 1938, to date, engineer with United States Fruit Company, Boston. Refers to *J. B. Babcock, 3d, F. H. Fay, C. M. Spofford, J. B. Wilbur.*

Sargent, John M. W., Clinton, Mass. (Age 30, b. Salem, Mass.) Attended Northeastern University, 1924–28. Co-operative periods at Northeastern, with Bradford & Weed, Civil Engineers and Surveyors, Lynn, Mass., 1924–28, as rodman and transitman; Beverly and Salem Water Supply Board, 1928, as transitman; city of Salem, engineering department, 1928–33, transitman and draftsman, on water, sewer, road construction and lay-outs, also land surveys; Metropolitan District Commission, Water Division, Wachusett Section, Clinton, Mass.; 1933 to present time, Grade II, civil engineer. Refers to *H. B. Alvord, C. O. Baird, Jr., A. S. Marble, R. M. Soule.*

Transfer from Grade of Student

Lenfest, Leslie W., Watertown, Mass. (Age 23, b. Union, Maine.) Graduated from Northeastern University, 1937, degree of B.S. in civil engineering, with high honor; received Desmond FitzGerald Scholarship in 1937; co-operative work while at Northeastern University, December, 1933, to November, 1935, with Barnes & Beal, Civil Engineers, Waltham, as draftsman, rodman and transitman; May, 1936, to April, 1937, with F. A. Joyce, Surveyor, Belmont, as draftsman and transitman; July and August, 1937, with Metropolitan Water Works as civil engineer, grade I; September, 1937, to date, with Northeastern University as assistant instructor in civil engineering and attending Harvard Graduate School of Engineering, 1937–38. Refers to *H. B. Alvord, C. O. Baird, Jr., A. E. Everett, Jr., E. A. Gramstorff.*

Squarebrigs, John N., Brookline, Mass. (Age 24, b. Boston, Mass.) Graduated from Brookline High School in 1932; graduated from Northeastern University in 1937, degree B.S. in civil engineering; April to June, 1936, with New England Survey Service as rodman and photographer; August to November, 1936, with Barnes & Beal, Surveyors, Waltham, as rodman and transitman; now with Town Engineering Department, Brookline, Mass., as rodman. Refers to *H. B. Alvord, C. O. Baird, Jr., A. E. Everett, Jr., E. A. Gramstorff.*

ADDITIONS

Members

Robert M. Becker, 181 Falls Street, Seneca Falls, N. Y.

Ernest L. F. Davis, 10 Myrtlebank Avenue, Dorchester, Mass.

James Hanlon, 26 Norman Street, Boston, Mass.

Waldo I. Kennerson, United States Engineer Office, Soil Laboratory, Providence, R. I.

Edwin S. Rich, 181 Roosevelt Avenue, Norwood, Mass.

Max Standke, 67 Perthshire Road, Brighton, Mass.

Junior

David Mayer, 95 Prescott Street, Cambridge, Mass.

Students

Joseph A. Caruso, 87 Cornell Street, Roslindale, Mass.

Adam A. Cook, 59 Franklin Street, Lynn, Mass.

Lloyd P. Crumb, 24 Francis Street, Brookline, Mass.

John J. Gill, 11 Mt. Vernon Avenue, Brighton, Mass.

Walter T. Grady, 4093 Washington Street, Roslindale, Mass.

Charles G. Hunt, 25 Manor House Road, Newton Center, Mass.

Gardner H. Lewis, 24 Francis Street, Brookline, Mass.

Charles A. de Luccia, 6 Cedar Court, Everett, Mass.

ANNUAL REPORTS

Report of Board of Government for the Year 1937–38

BOSTON, MASS., March 16, 1938.

To the Boston Society of Civil Engineers:

Pursuant to the requirements of the By-Laws, the Board of Government presents its report for the year ending March 16, 1938.

Membership

Twenty-seven new members, 2 juniors, 1 associate and 22 students have been added during the year, and 2 members, 3 juniors and 5 students have been reinstated, making a total addition of 62 members.

During the year 14 members have died, 15 have resigned, 3 members have had dues remitted and resignations accepted, 68 members have been dropped for non-payment of dues or failure to transfer, making a total deduction of 100.

The present net membership of the Society consists of 4 honorary members, 606 members, 60 juniors, 34 students, 10 associates, 1 member of Sanitary Section, making a total membership of 715, a net loss for the year of 38.

The honorary membership list now is as follows:

Charles T. Main, elected January 28, 1932.
Dr. Karl T. Compton, elected February 17, 1932.
Prof. C. Frank Allen, elected March 16, 1932.
Joseph R. Worcester, elected February 21, 1934.

Deaths

Members:
George H. Brazer, April 20, 1937.
Edgar S. Dorr, October 5, 1937.
Joseph Driscoll, May 26, 1937.
Harrison P. Eddy, June 15, 1937.
Charles H. Eglee, July 4, 1937.
William C. Hawley, August 16, 1937.
Neal J. Holland, December 2, 1937.
Francis H. Kendall, October 7, 1937.
Frank A. McInness, August 9, 1937.
James A. McKenna, June 15, 1937.
James A. McMurray, February 19, 1938.
Joseph F. Ross, October 3, 1937.
Edgar P. Sellew, October 20, 1937.
Leonard C. Wason, April 30, 1937.

Remission of Dues and Extension of Time

The membership of the Society has been subject during recent years to the effects of the depression. During this period the Board of Government has granted a number of members an extension of time for payment of dues and has remitted the dues of other members. With much regret the Board voted this year to drop from membership those who had not paid their 1937 dues, and others for failure to transfer, for which an extension had been granted. The Board has remitted dues and accepted resignations from 3 members.

The Board has granted 47 members an extension of time for payment of dues for year ending March 16, 1938, and for completion of pending transfers to higher grades.

Exemption of Dues

Eighty-two members are now exempt from dues in accordance with By-Law 8, which provides that "a member of any grade who has paid dues for forty years, or who has reached the age of seventy years and has paid dues for thirty years, shall be exempt from further dues."

Meetings of the Society

Eight regular meetings, since the annual meeting, have been held during the year.

The November meeting was the Annual Student Night, attended by Student Chapters, A. S. C. E., at Harvard, Massachusetts Institute of Technology, Tufts, Brown and Rhode Island State College, and the Northeastern University Section, B. S. C. E.

The total attendance at all meetings was 704 persons; the largest attendance was 175 and the smallest 50. Buffet suppers have been a feature of 8 meetings and they were well attended. The papers and addresses given were as follows:

March 17, 1937. — Annual meeting. Address of retiring President, Harold K. Barrows, "A Study of the Effect of Temperature upon Different Reactions and Processes," followed by dinner and entertainment.

April 21, 1937. — "Weather Forecasting, with Comments on Recent Floods," by Prof. Charles F. Brooks, Professor of Meteorology at Harvard University and Director of the Blue Hill Meteorological Observatory and Mount Washington Observatory. Illustrated.

May 19, 1937. — "The Recent Floods on the Mississippi River — The Flood Flows and Damages Incurred, and the Effectiveness of the Flood Control Measures already Carried Out," by Mr. Clarence E. Boesch, Chief, Flood Control Division, War Department, United States Engineers Office, Providence, R. I. Illustrated.

September 22, 1937. — "General Engineering Features of the Tennessee Valley Authority," by Mr. Harry A. Hageman, Chief Hydraulic Engineer, Tennessee Valley Authority. Illustrated.

October 20, 1937. — "The Results and Methods of Recent Off-shore Hydrographic Surveys," by Lieut. Paul A. Smith, United States Coast and Geodetic Survey, Washington, D. C. Illustrated.

November 17, 1937. — "New Types of Traffic Facilities," by Dr. Miller McClintock, Director of Bureau for Street Traffic Research, Harvard University. Student Night.

December 15, 1937. — "Large Scale Planning," by Mr. Lawrence M. Orton, Secretary and General Director, Regional Plan Association, Inc., New York City.

January 26, 1938. — "Control of Inter-State Stream Pollution," by Dr. Thorndike Saville, Dean of the College of Engineering, New York University, New York.

February 16, 1938. — "Planning for New England as a Whole," by Mr. Roland B. Greeley, Research Assistant, National Resources Committee, District No. 1, Boston, Mass. Illustrated.

Sections

Twenty-three meetings were held by the Sections of the Society during the year. These meetings of the Sections, offering opportunity for less formal discussion, have continued to demonstrate their value to their members and to the Society. The variety of subjects presented has made an appeal to the members, as indicated by the general attendance at these meetings.

Sanitary Section Meetings. — The Sanitary Section has held 7 meetings during the year, with an average attendance of 36. The papers and meetings are listed in the report of the executive committee.

Designers Section Meetings. — The Designers Section has held 8 regular meetings during the year. The average attendance has been 44. The papers and meetings are listed in the report of the executive committee.

Highway Section Meetings. — The Highway Section has held 4 regular meetings during the year, with an average attendance of 28.

Northeastern University Section. — The Northeastern University Section has held 4 meetings or trips during the year, with an average attendance of 28. The present student membership of the Section in attendance at the University is 34.

Journal

The complete report of the Editor of the JOURNAL for the calendar year 1937 will be printed in the April, 1938, JOURNAL.

Funds of the Society *

Permanent Fund. — The Permanent Fund of the Society has a present value of about $55,000. The Society again authorized the use of as much as necessary of the current income of this fund in payment of current expenses.

John R. Freeman Fund. — In 1925 the late John R. Freeman, a Past President and honorary member of the Society, made a gift to the Society of securities which was established as the John R. Freeman Fund, the income from which was about $1,400. The income from this fund is to be particularly devoted to the encouragement of young engineers. Mr. Freeman suggested several uses, such as the payment of expenses for experiments and compilations to be reported before the Society; for underwriting meritorious books or publications pertaining to hydraulic science or art; or a portion to be devoted to a yearly prize for the most useful paper relating to hydraulics contributed to this Society; or establishing a traveling scholarship every third year open to members of the Society for visiting engineering works, reports of which would be presented to the Society. Mr. Martin A. Mason † was awarded the John R. Freeman Scholarship for the year 1937–38. The Freeman Fund Committee authorized the expenditure for the publication of the paper by Mr. Leslie J. Hooper, Freeman Scholar, 1934–36, on "Representative Hydraulic Laboratories in the United States and Canada," which was issued as Section 2, Hydraulic Section, of the January, 1938, JOURNAL.

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* Details regarding the values and income of these funds are given in the Treasurer's report

† Mr. Mason is connected with the hydraulic laboratory of the National Bureau of Standards, Washington, D. C.

Edmund K. Turner Fund. — In 1916 the Society received 1,105 books from the library of the late Edmund K. Turner, and a bequest of $1,000, "the income of which is to be used for library purposes." The Board voted to use $50 of the income for the purchase of books for the library.

Alexis H. French Fund. — The Alexis H. French Fund, a bequest amounting to $1,000, was received in 1931 from the late Alexis H. French of Brookline, a former Past President of the Society. The income of this fund is "to be devoted to the library of the Society." The Board voted to use $50 of the available income for the purchase of books for the library.

Desmond FitzGerald Fund. — The Desmond FitzGerald Fund, established as a bequest from the late Desmond FitzGerald, a Past President and honorary member of the Society, provides that the income from this fund shall "be used for charitable and educational purposes." The Board voted on January 27, 1937, to appropriate from the income of this fund the sum of $100 to be known as the Boston Society of Civil Engineers Scholarship in memory of Desmond FitzGerald, and to be given to a student of Northeastern University. Presentation of this scholarship was made by Vice President Karl R. Kennison at a student meeting of the University on May 5, 1937, to Leslie W. Lenfest of Watertown, Massachusetts, a senior student in civil engineering. This year, on January 26, 1938, the Board voted to award a scholarship which will be presented to the selected student at a special meeting of the students to be held at an early date at the University.

Tinkham Memorial Fund. — The "Samuel E. Tinkham Fund," established in 1921 at the Massachusetts Institute of Technology by the Society "to assist some worthy student of high standing to continue his studies in civil engineering," had a value of $2,502.64 on June 30, 1937. Mr. Thomas Evans of Quincy, Massachusetts, a student in civil engineering in the class of 1938 at Technology, has been awarded this scholarship for the year 1937–38.

Clemens Herschel Fund. — This fund was established in 1931 by a bequest from the late Clemens Herschel, a former Past President and honorary member of the Society. The income from this fund is to be used for the presentation of prizes for particularly useful and commendable papers presented at meetings of the Society. The present value of this fund is about $1,000. The expenditure made during the year from this fund was for prizes.

Edward W. Howe Fund. — This fund, a bequest of $1,000, was received December 2, 1933, from the late Edward W. Howe, a former Past President of the Society. No restrictions were placed upon the use of this money, but the recommendation of the Board of Government is that the fund be kept intact, and that the income be used for the benefit of the Society or its members. The Board of Government authorized an expenditure of a portion of the income of this fund for the installation of new lighting units in the Library.

Desmond FitzGerald Medal

The Desmond FitzGerald Medal (bronze) was provided for in 1910 as an endowed prize by the late Desmond FitzGerald, a former Past President and honorary member of the Society. The prize is awarded annually to a member who presents an original paper to the Society which is published in the JOURNAL for the current year.

In accordance with the recommendation of the Committee on Awards, the Board of Government voted to award the Desmond FitzGerald medal to Donald W. Taylor, member, for his paper on "Stability of Earth Slopes," presented at a joint meeting of the Designers and Highway Sections, held on November 23, 1937, and published in the Journal for July, 1937.

Section Prizes

The Board of Government voted on April 12, 1924, to present a prize for a worthy paper given in each Section by a member of that Section, "this award to consist of books suitably inscribed."

Sanitary Section Prize. — The Board adopted the recommendation of the Sanitary Section Prize Committee, and voted that the Sanitary Section Prize be awarded to Robert Spurr Weston, member, for his paper on "The Treatment of Wool Scouring Waste," presented at a meeting of the Sanitary Section on April 7, 1937, and published in the July, 1937, Journal. The prize consisted of the following books: "American Sewerage Practice, Disposal of Sewage," Volume III, by Metcalf & Eddy; "Elimination of Taste and Odor in Water," by Baylis; and Manning's Formula Table.

Designers Section Prize. — The Board adopted the recommendations of the Designers Section Prize Committee, and voted that the Designers Section Prize be awarded to John B. Wilbur, member, for his paper on "Model Analyses of Structures," presented at a meeting of the Designers Section on December 8, 1937, and published in the January, 1938, Journal. The prize consisted of the following books: "Theory of Elastic Stability," by S. Timoshenko, and "Theory of Elasticity," by R. Southwell.

Clemens Herschel Award

The late Clemens Herschel, a former Past President and honorary member, gave to the Society a number of copies of his book on "Frontinus and the Water Supply of the City of Rome," with the request that the Board award one or more of the books each year as prizes for papers which have been particularly useful and worthy of grateful acknowledgment. On recommendation of the Desmond FitzGerald Committee on Awards, the Board voted to award a prize to Mr. Charles M. Noble for his paper entitled "The Factor of Safety in Highway Design," presented at a meeting of the Society held on January 27, 1937, and published in the April, 1937, Journal. The prize consisted of the book, "The Water Supply of the City of Rome," written by Clemens Herschel.

Social Activities

Seven of the regular meetings were held at the Engineers' Club and one meeting at Chipman Hall, Tremont Temple, preceded by buffet suppers, under the direction of the Social Activities Committee. As usual, the most enthusiastic meeting was Student Night, held in November, and attended by members of the Student Engineering Societies of Massachusetts Institute of Technology, Harvard, Tufts, Rhode Island State College, Brown University and Northeastern University Section of the Boston Society of Civil Engineers. An excursion to recent engineering work in metropolitan areas, Haverhill and Hampton Beach, N. H., was planned, but cancelled on account of lack of adequate attendance.

Library

The Report of the Committee on Library contains a complete account of the library activities during the past year.

Society Activities

The Board of Government made provision for the participation of members of the Society in extending hospitality to the officers of the American Society of Civil Engineers and of the Engineering Institute of Canada on the occasion of the Fall Meeting of the American Society of Civil Engineers held in October, 1937. A joint dinner, sponsored by the members of the Board of Government of the Boston Society of Civil Engineers and the Northeastern Section, American Society of Civil Engineers, was held at the Armory of the Ancient and Honorable Artillery Company at Faneuil Hall, Boston, on October 6, 1937, at which the guests were the officers of the American Society of Civil Engineers and the Engineering Institute of Canada, and their ladies, which was attended by about 180 persons.

The usual special committees dealing with the general activities and conduct of the Society have included the following: Program, Publication, Membership and Publicity, Library, Social Activities, Relation of Sections to Main Society, and Membership Records. Other special committees have included the following: Run-off, 1936 Floods, Desmond FitzGerald and other prizes, and John R. Freeman Fund and Welfare Committee. Each of these committees has made a distinct contribution to the Society and has developed fields of endeavor which will prove of great benefit to the members.

The Society has co-operated with the Engineering Societies of New England, and many members of the Society have served on Engineering Societies' committees.

Your Board, in conclusion, wishes to express its appreciation of the excellent work done by the officers of the Sections and by the committees of the Society.

ARTHUR D. WESTON, *President.*

Report of the Treasurer

BOSTON, MASS., March 10, 1938.

To the Boston Society of Civil Engineers:

The appended tables show the financial standing of the Society at the close of the fiscal year, March 10, 1938.

Table 1. Distribution of Funds — Receipts and Expenditures.
Table 2. Record of Investments.

It has been necessary to transfer $1,735.62, or about 69 per cent of the income of the Permanent Fund, to the Current Fund to meet current expenses of the past year, and to re-establish the Current Fund at $1,500. Receipts from dues and their relation to expenses for the past five years are shown below:

	1933–34	1934–35	1935–36	1936–37	1937–38
Net expenditures (except such as provided for by appropriations other than Permanent Fund income)	$7,228	$7,609	$6,333	$6,807	$6,622
Receipts from dues	5,540	5,390	5,115	5,358	4,886
Deficit	$1,688	$2,219	$1,218	$1,449	$1,736

The income from all investments has been pooled and allocated to the various funds on the basis of the respective book values at the beginning of the year. Interest and dividends for the year totaled $4,130.44, or 4.57 per cent of the total book value as of March 10, 1937, a somewhat less return than for the previous year. The total amount of interest and dividends was $347.13 less than for the previous year.

On account of the general financial uncertainty, the Investment Committee felt that the Society should get expert advice with respect to the invested funds, and with the approval of the Board of Government, arrangements have been made to obtain a periodic review of the investments. It is expected that this will result in strengthening our list of securities.

The changes in the two principal funds during the past five years are given below:

	March 10, 1934	March 10, 1935	March 10, 1936	March 10, 1937	March 10, 1938
Permanent Fund:					
Book value	$50,348	$51,932	$52,695	$54,865	$55,064
Market value in per cent of book value	91.42%	90.92%	99.87%	103.90%	84.17%
John R. Freeman Fund:					
Book value	$26,902	$26,999	$27,359	$29,073	$26,679
Market value in per cent of book value	66.01%	61.12%	99.87%	103.90%	84.17%

The reduction in the John R. Freeman Fund is brought about by the fact that during the past year the Society awarded a traveling scholarship to Mr. Martin A. Mason of the National Bureau of Standards, Washington, D. C., and published in the January, 1938, JOURNAL the Report of Mr. Leslie J. Hooper, the John R. Freeman Scholar of the Boston Society of Civil Engineers, 1934–36.

The total book value of all holdings on March 10, 1938, is $89,580.74, not including the value of the library and furniture, which for many years has been carried on the books at $9,905.11.

Respectfully submitted,

CHARLES R. MAIN, *Treasurer*

TABLE 1. — DISTRIBUTION OF FUNDS — RECEIPTS AND EXPENDITURES

	Book Value March 10, 1937	Interest and Dividends	Net Profit (or Loss) at Sale or Maturity	TRANSFER OF FUNDS		Book Value March 10, 1938
				Purchased	Sold	
Bonds	$32,236 34	$1,414 15	$78 51	$2,890 00	$2,006 14	$33,198 71
Co-operative banks	14,292 80	451 48	–	1,589 83	2,297 42	13,585 21
Stocks	44,930 09	2,264 81	−1,777 01	4,795 83	6,201 74	41,747 17
Cash (except Current Fund)	−1,092 83	–	–	642 48*	–	−450 35
Total	$90,366 40	$4,130 44	−$1,698 50	$9,918 14	$10,505 30	$88,080 74

	Book Value March 10, 1937	ALLOCATION OF THE ABOVE —		Miscellaneous Receipts	Miscellaneous Expenditures	Book Value March 10, 1938
		At 4.57%	At 1.88%			
Permanent Fund	$54,865 45	$2,507 85	−$1,031 00	$457 00†	$1,735 62	$55,063 68
John R. Freeman Fund	29,072 97	1,328 90	−546 30	–	3,176 13	26,679 44
Edmund K. Turner Fund	1,014 68	46 35	−19 20	–	47 80	994 03
Desmond Fitzgerald Fund	2,123 50	97 05	−40 00	–	100 00	2,080 55
Alexis H. French Fund	1,027 63	46 94	−19 40	–	47 05	1,008 12
Clemens Herschel Fund	1,184 07	54 10	−22 30	–	41 00	1,174 87
Edward W. Howe Fund	1,078 10	49 25	−20 30	–	27 00	1,080 05
	$90,366 40	$4,130 44	−$1,698 50	$457 00	$5,174 60‡	$88,080 74
Current Fund	1,500 00	–	–	8,818 63‡	8,818 63	1,500 00
Total, all funds	$91,866 40	$4,130 44	−$1,698 50	$9,275 63‡	$13,993 23‡	$89,580 74

* Net increase.

† Entrance fees.

‡ Includes transfer of $1,735.62 from income of Permanent Fund to the Current Fund.

TABLE 2. — RECORD OF INVESTMENTS.

	Date of Maturity or Classification	Fixed or Current Interest Rate	DURING THE YEAR MARCH 10, 1937, TO MARCH 10, 1938				MARCH 10, 1938		
					SOLD OR MATURED				
			Interest or Dividends Received	Additional Amount Invested	Amount Received	Profit (or Loss)	Par Value or Number of Shares	Book Value	Market Value
Bonds									
Baltimore & Ohio R.R.	Aug. 1, 1939	4½%	$74 87	$1,015 00	–	–	$2,000 00	$2,013 75	$820 00
The Boston Terminal Co.	July 1, 1950	4 %	40 00	–	–	–	1,000 00	1,000 00	990 00
Canadian Pacific R.R.	July 2, 1949	4 %	189 28	–	–	–	5,000 00	5,342 50	4,750 00
Central Maine Power Co.	Oct. 1, 1960	4 %	80 00	–	–	–	2,000 00	2,035 36	2,075 00
Central Power & Light Co.	Aug. 1, 1956	5 %	50 00	–	–	–	1,000 00	1,005 00	872 50
Chicago & Northwestern Ry. Co.	Nov. 1, 1987	5 %	–	–	–	–	1,000 00	1,102 50	180 00
The Cleveland Union Term. Co.	Apr. 1, 1973	5 %	50 00	–	–	–	1,000 00	998 75	820 00
The Cleveland Union Term. Co.	Oct. 1, 1977	4½%	45 00	–	–	–	1,000 00	980 00	760 00
Cons. Water Co. of Utica, N. Y.	May 1, 1958	4½%	135 00	–	–	–	3,000 00	3,037 50	2,670 00
Illinois Power & Light Co.	Dec. 1, 1956	5 %	50 00	–	–	–	1,000 00	981 25	860 00
Louisiana Power & Light Co.	Dec. 1, 1957	5 %	50 00	–	–	–	1,000 00	835 00	1,042 50
Mississippi Power & Light Co.	Dec. 1, 1957	5 %	50 00	–	–	–	1,000 00	972 50	750 00
Pennsylvania Power & Light Co.	Apr. 1, 1981	4½%	55 25	–	$2,006 14	$78 51	–	–	–
The Pennsylvania Railroad Co.	June 1, 1965	4½%	45 00	–	–	–	1,000 00	1,017 74	1,000 00
The Pennsylvania Railroad Co.	Apr. 1, 1970	4½%	45 00	–	–	–	1,000 00	971 58	880 00
Peoria Water Works Co.	Aug. 1, 1950	5 %	50 00	–	–	–	1,000 00	1,010 00	1,015 00
Southern California Water Co.	Oct. 1, 1960	4½%	29 75	1,875 00	–	–	2,000 00	1,875 00	1,790 00
Southern Pacific Co.	Mar. 1, 1977	4½%	45 00	–	–	–	1,000 00	955 00	630 00
Southwestern Gas & Electric Co.	Nov. 1, 1960	4 %	40 00	–	–	–	1,000 00	995 00	1,035 00
Tennessee Public Service Co.	Oct. 1, 1970	5 %	50 00	–	–	–	1,000 00	1,002 50	705 00
Texas Electric Service Co.	July 1, 1960	5 %	100 00	–	–	–	2,000 00	2,000 00	1,790 00
The Toledo Edison Co.	Nov. 1, 1962	5 %	100 00	–	–	–	2,000 00	2,085 00	2,137 50
Western Maryland R.R. Co.	Oct. 1, 1952	4 %	40 00	–	–	–	1,000 00	982 78	877 50
Total, bonds	–	–	$1,414 15	$2,890 00	$2,006 14	$78 51	$33,000 00	$33,198 71	$28,450 00

TABLE 2. — RECORD OF INVESTMENTS — *Concluded*

	Date of Maturity or Classification	Fixed or Current Interest Rate	DURING THE YEAR MARCH 10, 1937, TO MARCH 10, 1938				MARCH 10, 1938		
			Interest or Dividends Received	Additional Amount Invested	SOLD OR MATURED		Par Value or Number of Shares	Book Value	Market Value
					Amount Received	Profit (or Loss)			
Co-operative Banks									
Codman Co-operative Bank .	Ser. 37, 1942	4 %	$92 00	$332 00	–	–	20	$2,550 00	$2,550 00
Merchants Co-operative Bank .	Ser. 140, 1940	3¼%	174 35	629 35	$714 80	–	35	5,257 35	5,257 35
Suffolk Co-operative Bank . .	Ser. 134, 1940	3 %	158 48	628 48	1,582 62	–	30	4,777 86	4,777 86
Suffolk Co-operative Bank . .	Mat. shares	3 %	26 65	–	–	–	5	1,000 00	1,000 00
Total, co-operative banks .	– –	–	$451 48	$1,589 83	$2,297 42	–	–	$13,585 21	$13,585 21
Stocks									
Alabama Power Co. . . .	Cum. Pref. 7%	$7 00	$70 00	–	$514 30	–$465 70	–	–	–
American Tel. & Tel. Co. . .	Common	9 00	414 00	–	–	–	46	$5,346 04	$6,089 25
Bankers Trust Co. . . .	Common	2 00	20 00	$950 00	–	–	30	1,590 00	1,410 00
Carolina Power & Light Co. .	Cum. Pref. 7%	7 00	35 00	–	919 30	–100 70	–	–	–
Commonwealth & Southern Corp.	Cum. Pref.	3 00	24 00	–	–	–	8	1,019 89	323 13
Commonwealth & Southern Corp.	Common	–	–	–	–	–	25		
Commonwealth & Southern Corp.	Opt. Warrants	–	–	–	–	–	12		
Consolidated Gas of N. Y. . .	Common	2 00	40 00	–	–	–	20	1,906 50	420 00
Electric Power & Light Corp. .	Common	–	–	–	82 30	18 55	–	–	–
General Electric Co. . .	Common	2 20	110 00	–	–	–	50	2,341 47	1,931 25
Hartford Fire Insurance Co. .	Common	2 00	10 00	761 25	–	–	20	761 25	1,325 00
Home Insurance Co. . . .	Common	1 60	49 60	–	–	–	31	1,245 00	844 75
Home Insurance Co. . . .	Script. Cert.	–	–	–	1 08	1 08	–	–	–
Minnesota Power & Light Co. .	Pref. 7%	9 34	93 40	–	–	–	10	980 00	750 00
National Dairy Products . .	Common	1 20	60 00	–	–	–	50	1,154 74	693 75
National Fire Insurance Co. .	Common	2 00	30 00	1,240 00	–	–	20	1,240 00	1,100 00
New England Power Associates .	Pref.	6 00	120 00	–	–	–	20	1,815 00	970 00
New York Central R.R. Co. .	Common	–	–	–	–	–	10	870 45	165 00

New York Central R.R. Co. .	Frac. Warrant	–	–	–	4 07	4 07	–	–	–
North American Trust Shares .	Cum. July 15, '55	156	234 00	–	–	–	1,500	5,342 00	3,645 00
Northwestern Electric Co. . .	Cum. 1st Pref.	7 00	70 00	–	574 30	–405 70	–	–	–
Pacific Gas & Electric Co. . .	Cum. 1st Pref. 6%	1 50	90 00	–	–	–	60	1,922 02	1,840 00
Pacific Gas & Electric Co. . .	Cum. 1st Pref. 5½%	1 376	27 52	–	–	–	20		
Pacific Gas & Electric Co. . .	Common	2 00	128 00	–	–	–	64	1,808 79	1,664 00
Pennsylvania Gas & Elec. Corp. .	Pref.	7 00	52 50	–	2,442 30	–512 70	–	–	–
Southern Cal. Edison Co. Ltd. .	Cum. Orig. Pref.	1 625	65 00	–	–	–	40	1,161 22	1,400 00
Southern Cal. Edison Co. Ltd. .	Common	1 625	35 00	–	–	–	20	539 75	422 50
Standard Oil Co. of N. J. . .	Common	2 50	–	479 54	–	–	10	479 54	497 50
Tampa Electric Co. . . .	Common	2 24	67 20	–	–	–	30	1,151 25	825 00
Tampa Electric Co. . . .	Rights	–	–	–	8 96	8 96	–	–	–
The Tennessee Elec. Power Co. .	1st Pref.	7 00	70 00	–	459 30	–490 70	–	–	–
The Timken Roller Bearing Co. .	Common	4 50	63 75	–	–	–	15	1,018 97	630 00
Trimount Dredging Co. . .	Pref. C	–	–	–	–	–	2	–	–
U. S. Smelting, Ref. & Mining Co.	Pref.	3 50	52 50	1,365 04	–	–	20	1,365 04	1,400 00
United States Steel Corp. . .	Common	1 00	10 00	–	–	–	10	860 75	528 75
United States Trust Co. of Boston	Conv. Pref.	733	165 00	–	–	–	225	4,837 50	3,262 50
Utah Power & Light Co. . .	Cum. Pref.	4 084	40 84	–	–	–	10	990 00	350 00
West Penn. Power Co. . .	Cum. Pref.	7 00	17 50	–	1,195 83	165 83	–	–	–
Total, stocks . . .	– –	–	$2,264 81	$4,795 83	$6,201 74	–$1,777 01	–	$41,747 17	$32,487 38

Report of the Secretary

Boston, March 5, 1938.

To the Boston Society of Civil Engineers:

The following is a statement of cash received by the Secretary, and of the expenditures approved by the President, in accordance with the budget adopted by the Board of Government for the year ending March 16, 1938:

	Account Number	Current Fund Account		Credit Transfers by Treasurer	Net Distribution under Budget	
		Expenditures	Cash Receipts		Expenditures	Receipts
Office:						
Secretary — salary and expense	(1)	$240 00	–	–	–	–
Stationery, printing and postage	(2)	249 14	–	–	–	–
Incidentals and petty cash	(3)	471 22	–	–	–	–
Insurance and Treasurer's bond	(4)	56 50	–	–	–	–
Safety deposit box	(5)	11 00	–	–	–	–
Quarters, rent, light, telephone	(7)	1,779 67	$622 00*	–	–	–
Office, clerical	(8)	1,440 00	–	–	–	–
Auditors for 1937 accounts and investment services	(9)	150 00	–	–	–	–
Total		$4,397 53	$622 00	–	$3,775 53	–
Meetings:						
Rent of halls, etc.	(11)	$196 80	–	–	–	–
Stationery, printing and postage	(12)	77 02	–	–	–	–
Social activities	(13)	145 45	–	–	–	–
Stereopticon and reporting	(14) (15)	–	–	–	–	–
Annual meeting (March, 1937)	(16)	94 30	–	–	–	–
Total		$513 57	–	–	$513 57	–

Sections:						
Sanitary Section	(21)	$26 60	–	–	–	–
Designers Section	(22)	26 25	–	–	–	–
Highway Section	(23)	8 00	–	–	–	–
Northeastern University Section	(24)	–	–	–	–	–
Total		$60 85	–	–	$60 85	–
Journal:						
Editor — salary and expense	(31)	$308 00	–	–	–	–
Printing and postage	(32)	2,391 17	–	–	–	–
Advertising, commission and receipts	(34)	236 70	$1,139 00	–	–	–
Sales of JOURNALS	(35)	–	313 56	–	–	–
Total		$2,935 87	$1,452 56	–	$1,483 31	–
Library:						
Librarian — salary and expense	(41)	$54 91	–	–	–	–
Periodicals	(43)	95 00	$5 00†	–	–	–
Binding	(44)	10 75	–	–	–	–
Total		$160 66	$5 00	–	$155 66	–
Miscellaneous:						
Library fines	(45)	–	$4 51	–	–	–
Badges for members	(51)	$80 75	80 75	–	–	–
Binding JOURNALS for members	(52)	26 00	32 00	–	–	–
Bank charges	(53)	15 34	–	–	–	–
Total		$122 09	$117 26	–	$4 83	–

* From Engineering Societies of New England, $600.

† Refund on subscription.

	Account Number	CURRENT FUND ACCOUNT		Credit Transfers by Treasurer	NET DISTRIBUTION UNDER BUDGET	
		Expenditures	Cash Receipts		Expenditures	Receipts
Engineering Societies of New England	(59)	$628 06	–	–	$628 06	–
Dues from members	(70)	–	$4,886 19	–	–	$4,886 19
Income from Permanent Fund		–	–	$1,735 62	–	1,735 62
Total Current Fund		$8,818 63	$7,083 01	$1,735 62	$6,621 81	$6,621 81
Entrance fees, to Permanent Fund (27 new members, 2 juniors, 1 associate, 22 students, 15 juniors transferred to members, and 8 students transferred to junior, and 1 student transferred to member)		–	$457 00	–	–	$457 00

The above cash receipts have been paid to the Treasurer, whose receipt the Secretary holds.

Respectfully submitted,

EVERETT N. HUTCHINS, *Secretary.*

Report of the Auditing Committee

BOSTON, March 16, 1938.

We have reviewed the records and accounts of the Secretary and Treasurer of the Boston Society of Civil Engineers and the report of William J. Hyde, Certified Public Accountant, who has examined said records and accounts, and we have examined the securities enumerated by the Treasurer.

We have accepted and present herewith with our approval the signed report of the Auditor.

A. B. EDWARDS,
HOWARD M. TURNER,
Auditing Committee of the Directors of the Boston Society of Civil Engineers.

STATEMENT OF CERTIFIED PUBLIC ACCOUNTANT

BOSTON, March 15, 1938.

Mr. A. B. EDWARDS, *Chairman of the Auditing Committee, Boston Society of Civil Engineers, Boston, Massachusetts.*

DEAR SIR: — In accordance with your instructions, I have performed the annual audit of the financial records of the Society for the fiscal year ending March 10, 1938.

Securities held by the Society as at March 10, 1938, were examined and were found to correctly reflect the changes occurring within the year under review. All coupons for interest due were collected except five of the Chicago & Northwestern Railway Company, total $125, which are in default. Dividends earned were verified and all were correctly accounted for. The records of purchases and sales of securities were in agreement with brokers' statements.

Receipts reported as coming from the Secretary were compared with his records and were found to be correctly entered in the Treasurer's accounts.

Co-operative bank earnings were verified and found correct.

All vouchers paid were approved by the President and payment substantiated by examination of cancelled checks.

A verified copy of your Treasurer's report is attached hereto, and summarizes the detailed records of his ledger, all of which detail I have carefully checked and found in excellent condition.

Respectfully submitted,

W. J. HYDE,
Certified Public Accountant.

Report of the Editor

BOSTON, MASS., January 8, 1938.

To the Board of Government, Boston Society of Civil Engineers:

The JOURNAL for the calendar year 1937 (Volume XXIV) was issued quarterly, in the months of January, April, July and October, as authorized by the Board of Government on December 20, 1935.

During the year 1937 there have been published ten papers presented at meetings of the Society and Sections, and one other technical article. The Contents and Index for the year 1937 are included in the October, 1937, issue.

The four issues of the JOURNAL contained 334 pages of papers and discussions, 6 pages of Index, and 40 pages of advertising, a total of 380 pages. An average of 1,203 copies per issue were printed. The net cost was $1,375.62 as compared with $1,711.16 for the preceding year.

Table I includes a comparison of the costs for the JOURNAL from 1933 to 1937, inclusive. In Table II details of cost for Volume XXIV of the JOURNAL for the calendar year 1937 are shown.

Respectfully submitted,

EVERETT N. HUTCHINS, *Editor.*

TABLE I. — COMPARISON OF COSTS OF JOURNAL, 1933–37, INCLUSIVE.

YEAR	Volume	Number of Pages*	Gross Total†	Cost per Page	Net Total‡	Cost per Page	Number of Cuts and Inserts
1933 . . .	XX	331	$2,265 51	$6 84	$1,389 36	$4 17	82
1934 . . .	XXI	383	2,966 67	7 74	2,081 37	5 43	126
1935 . . .	XXII	323	2,628 16	8 13	2,091 41	6 47	119
1936 . . .	XXIII	356	2,666 42	7 49	1,711 16	4 80	90
1937 . . .	XXIV	380	2,737 48	7 20	1,375 62	3 62	101

* Includes Advertising Section and Annual Index.

† Gross cost includes editing, printing and mailing.

‡ Net cost equals gross cost less amounts received for advertising, subscriptions and sales of JOURNALS.

TABLE II. — 1937 JOURNAL — VOLUME XXIV

	Issues of —				
	January	April	July	October	Total
Number of pages:					
Papers and discussions	55	140	96	49*	340
Advertising and advertisers' index	10	10	10	10	40
Total pages	65	150	106	59	380
Number of cuts	38	28	23	12	101
Cost of Journal					
Composition and printing	$325 91	$737 03	$588 69	$263 13	$1,914 76
Cuts	115 11	133 23	98 75	53 92	401 01
Wrapping, mailing and postage	–	–	–	–	113 71
Editing	–	–	–	–	300 00
Copyright	–	–	–	–	8 00
Total gross cost of JOURNAL	–	–	–	–	$2,737 48

Receipts from subscriptions and sales of JOURNALS and reprints	$285 56	
Receipts (net) from advertising	1,076 30	
Total receipts		1,361 86
Net cost of JOURNAL		$1,375 62

* Includes 6 pages of Index of 1937 JOURNAL.

Report of the Committee on Social Activities

BOSTON, March 16, 1938.

To the Boston Society of Civil Engineers:

The Committee on Social Activities submits the following report for the year 1937–38.

Seven regular meetings were held at the Engineers' Club during the year. The total number of members and guests served with buffet supper was 352, or an average of 50 persons per meeting. This average is less by 24 than for the previous year, and is equal to the average for the year 1934–35. The smallest number served was 40 and the largest 58. An average of 12 additional persons attended the meetings following the supper — 19 less than the year before.

Ninety-two members and guests attended the annual dinner at the Chamber of Commerce Building.

One hundred and fifty-two were served at the Student Night Meeting at Tremont Temple in November. This was the same as the previous year. This meeting included the Student Chapters of the American Society of Civil Engineers at Harvard, Tufts, Massachusetts Institute of Technology, Rhode Island State College, Brown University, and the Northeastern University Section of the Boston Society of Civil Engineers. The attendance at the meeting following the supper was 175.

The excursion to Hampton Beach, N. H., in June was cancelled because of lack of interest.

A total of nine meetings were held during the year, as follows:

March 17, 1937 — Annual dinner, Chamber of Commerce.
April 21, 1937
May 19, 1937
Sept. 22, 1937
Oct. 20, 1937 } Regular meetings, Engineers' Club.
Dec. 15, 1937
Jan. 21, 1938
Feb. 16, 1938
November 17, 1937 — Student Night, Tremont Temple.

The average attendance at meals for all these meetings was 66. The average attendance at the meetings was 78.

The cost to the Society of supper at the Engineers' Club was $1.25, and the charge to members was continued at 65 cents and to guests at $1.

Respectfully submitted,

JOHN H. HARDING, *Chairman.*

Report of the Committee on Relation of Sections to the Main Society

To the Boston Society of Civil Engineers:

This Committee, consisting of the Chairmen of the four Sections, has held no formal meetings but did co-operate in arranging a joint meeting of the Highway and Designers Sections on November 23, 1937.

A year ago it was suggested that the individual membership lists of the Highway, Designers and Sanitary Sections be eliminated and all members of the Society be considered members of these Sections. Favorable action was taken by the Designers Section and Highway Section, but no action was taken by the Sanitary Section.

Due to our present method of printing meeting notices in the weekly Journal of the Engineering Societies of New England, it has been demonstrated again this year that the use of individual mailing lists would occur only rarely. It has been suggested that since the need of sending special notices occurs very infrequently, it would be advantageous to dispense with the individual lists and use the full membership list when these occasions arise. It is hoped that the Sanitary Section will consider this proposal again in view of the above facts.

Respectfully submitted,

For the Committee,

HERMAN G. DRESSER, *Chairman.*

Report of the Committee on Welfare

BOSTON, March 16, 1938.

To the Boston Society of Civil Engineers:

During the past year no matters relating to the welfare of members of the Society have come to the attention of the Welfare Committee for its action. It therefore has not been necessary to hold any meeting of the Committee during the year.

The employment service offered by the Emergency Planning and Research Bureau, Inc., is now recognized as a clearing house through which engineers and engineering employees in this territory should seek employment. On May 1, 1937, the Emergency Planning and Research Bureau, Inc., adopted the practice of charging for placing its registrants in private employment. The fee established for each placement is 7½ per cent of the wages received up to a limit of ten weeks of work, payable each pay day; placement on Federal relief pay roll is made without any fee being charged. The establishment of a fee for placements made by the Bureau has been well received by those who have obtained positions.

During the year 1937 total registrations at the Bureau increased from 1,030 to 1,501. On March 1 there were about 85 members of the Boston Society of Civil Engineers registered with the Bureau. Placements made by the Bureau in 1937 were substantially in excess of those made in 1936 up until September of 1937. During the month of September and through the end of the year there was a very pronounced falling off in placements by the Bureau, and this condition has maintained up to the present time.

It is strongly recommended that all members of the Society make full use of the registration and placement facilities offered by the employment service of the Emergency Planning and Research Bureau, Inc.

Respectfully submitted,

RALPH W. HORNE, *Chairman.*

Report of the Library Committee

BOSTON, March 8, 1938.

To the Boston Society of Civil Engineers:

Due to limitation of library space, it was necessary this year to clear the shelves of older books to provide room for new books. A total of 68 carefully selected volumes were discarded releasing about 10 linear feet of shelf space. Books published prior to 1860 were retained because of their possible historical value. The discarded books are being disposed of by the Librarian.

The appropriation for the purchase of new books was $100. A list of additions to the library, including donated books, is given in the Appendix to this report.

The number of books loaned during the year is 175.

A total of $4.51 was collected in fines.

Respectfully submitted,

EUGENE MIRABELLI, *Chairman.*

APPENDIX.

The following books were donated to the Society:

"Theory of Continuous Structures and Arches," by C. M. Spofford, gift of the author.
"Manual of Structural Planning and Design," by Geo. E. Strehan, gift of Arthur D. Weston.
"Hydraulic Structures," Vols. 1 and 2, Ing. Dr. Tech. Armin Schoklitsch, gift of Chas. T. Main.
"A. R. E. A. Manual, 1936," gift of Prof. C. Frank Allen.
"Design of Reinforced Concrete Structures," by Dean Peabody, Jr., gift of the author.
"Report of the New York State Committee on Ventilation, 1923," gift of Weston and Sampson.
"Theory of Statically Indeterminate Structures," by Fife and Wilbur, gift of the authors.
"Civil Engineer's Reference Book," by Trautwine, gift of Maj. Wm. A. Balch, U. S. A., retired.
"Bridges in History and Legend," by Watson and Watson, gift of the authors.
"A Decade of Bridges," by W. J. Watson, gift of the author.

The following books were purchased:

"Procedure Handbook of Arc Welding Design and Practice." Lincoln Electric Company.
"First Elevated Railroads in Manhattan and the Bronx in New York City." New York Historical Society.
"Proceedings, 16th Annual Meeting, Highway Research Board." National Research Council.
"Engineering Properties of Soil." C. A. Hogentogler.
"Public Works Engineers Yearbook." American Public Works Association.
"Who's Who in Engineering," 1937 edition. Lewis Historical Society.
"Plumbing Engineering." Walter S. L. Cleverdon.
"Handbook of Engineering Fundamentals." Ovid W. Esbach.
"Applied Fluid Mechanics." O'Brien and Hickox.
"Essentials of Engineering Astronomy." Jerry H. Service.
"Supervision of Construction." W. W. Beach.

"Invention and the Law." Harry A. Toulmin, Jr.
"Hydraulics of Open Channels." Boris A. Bakhmeteff.
"Water Treatment and Purification." Wm. J. Ryan.
"Theory of Elasticity." S. Timoshenko.
"Theory of Elastic Stability." S. Timoshenko.
"Building Height, Bulk and Form." Geo. B. Ford.
"Urban Land Uses." Harland Bartholomew.
"Model Laws for Planning Cities, Counties and States." Edw. M. Bassett.
"Bibliography of Planning, 1928–1935." Katherine McNamara.
"Ground Water." C. F. Tolman.
"Preventive Medicine and Hygiene." Milton J. Rosenau.
"Soil Mechanics and Foundations." F. L. Plummer.

Report of the Committee on John R. Freeman Scholarship Fund

BOSTON, March 16, 1938.

To the Boston Society of Civil Engineers:

The report of Mr. Leslie J. Hooper, Freeman scholar for 1934 to 1937, inclusive, on the hydraulic laboratories of this country, has been published as the Hydraulic Section of the issue of the JOURNAL of the Society of January, 1938.

Mr. Martin A. Mason was awarded the Freeman scholarship for the year 1937–38 and is now in Europe. Mr. Mason was connected with the hydraulic laboratory of the National Bureau of Standards at Washington, D. C., and it is expected that he will return to the Bureau after the completion of his scholarship.

Some question has arisen as to whether the results obtained from the Freeman scholarships are worth the expenditure of time and money spent on them. In order to answer this question your Freeman Fund Committee, with the assistance of the American Society of Civil Engineers, the American Society of Mechanical Engineers, and Mr. Clarke Freeman, has gone over the records of accomplishment of the Freeman scholars, as far as they are available, and it is the unanimous conclusion that the results have been, on the whole, satisfactory and as good or better than Mr. Freeman anticipated when he established the funds with the three societies.

CHARLES T. MAIN,
Chairman, Freeman Fund Committee.

Report of the 1936 Flood Committee

BOSTON, March 16, 1938.

The work of this Committee is not completed, so that this is, of necessity, only a report of progress. The publication of the United States Geological Survey Water Supply Paper on the 1936 Flood in New England, last July, made available for study the complete basic data of the flood flow. The reports of the army engineers, on their studies, however, are not yet available. The work of the Committee has been divided up into various subcommittees, each one studying a different subject. Reports from these subcommittees show that most of them have their work under way.

The plans for flood control in the Merrimack and Connecticut rivers covered by the State compacts were completed last year and submitted to Congress. It was suggested last autumn that the Flood Committee might well express an opinion on these plans which, at that time, were as they still are — subject to controversy. The subcommittee on "Flood Control Plans for New England" discussed this matter very thoroughly and decided that even if an opinion could have been reached by the Committee at that time no useful purpose would be served by its publication.

It is hoped that the Committee's report will be completed before the next annual meeting of the Society.

HOWARD MOORE TURNER, *Chairman.*

Report of the Executive Committee of the Sanitary Section

BOSTON, March 2, 1938.

To the Sanitary Section, Boston Society of Civil Engineers:

During the past year seven meetings have been held and papers were presented as follows:

March 3, 1937. — "Experiences During the Recent Ohio River Flood," by E. Sherman Chase, Gail P. Edwards and Arthur V. Harrington.

April 7, 1937. — "The Treatment of Wool Scouring Wastes," by Robert Spurr Weston.

June 12, 1937. — Excursion to Leominster, Mass., where an inspection was made of the sewage treatment plant and of the water treatment plant.

October 7, 1937. — Meeting with the Sanitary Engineering Division of the American Society of Civil Engineers — "Studies of the Pollution of Boston Harbor and its Tributary Waters," by Arthur D. Weston and Gail P. Edwards, and "The Decomposition of River Deposits," by Gordon M. Fair.

November 3, 1937. — Joint meeting with the Northeastern Section, American Society of Civil Engineers — "Light on Air-Borne Infection," by William Firth Wells.

November 12, 1937. — "Some Features of the New 420 M. G. D. Detroit Sewage Treatment Plant," by A. B. Morrill.

February 2, 1938. — "Sanitation of Trailer Camps," by Ralph M. Soule.

Attendance at these meetings has varied from 20 to 69, and has averaged 36. Executive Committee meetings have been held prior to each section meeting.

Respectfully submitted,

For the Executive Committee,

RALPH M. SOULE, *Clerk.*

Report of the Executive Committee of the Designers Section

BOSTON, March 9, 1938.

To the Designers Section, Boston Society of Civil Engineers:

The following is a list of the meetings which took place during the year March, 1937, to March, 1938:

March 10, 1937. — Mr. B. J. Fletcher spoke on "The Use of Aluminum Alloy in Structures." *Attendance*, 35.

April 14, 1937. — Mr. John C. Moses spoke on "The Repair of Flood Damaged Bridges." *Attendance*, 31.

May 12, 1937. — Mr. Miles N. Clair spoke on the "Relation of the Testing Laboratory to the Engineer and Architect." *Attendance*, 45.

October 13, 1937. — Mr. Henry A. Mohr spoke on "Recent Developments in the Construction of Deep Caissons." *Attendance*, 59.

November 23, 1937. — Joint Meeting with the Highway Section. Mr. Donald W. Taylor spoke on the "Stability of Earth Slopes." *Attendance*, 40.

December 8, 1937. — Meeting held at Massachusetts Institute of Technology. Prof. John B. Wilbur spoke on "Instruments and Materials Used in Testing Structural Models." *Attendance*, 45.

January 12, 1938. — Mr. Frederick H. Crabtree spoke on the subject, "Geology from the Engineering Viewpoint." *Attendance*, 45.

February 9, 1938. — Prof. Robinson Abbott and Mr. Albert Kleinert spoke on "Development of Highway Bridges During the Last Ten Years." *Attendance*, 54.

The total attendance at the meetings was 354.

During the year a motion was passed, as the result of which all regular members of the Boston Society, are considered as members of the Sections.

Respectfully submitted,

J. D. MITSCH, *Clerk*.

Report of Executive Committee of the Highway Section

BOSTON, February 23, 1938.

To the Highway Section, Boston Society of Civil Engineers:

During the past year the section held the following four meetings:

February 24, 1937. — Annual meeting, election of officers. Prof. Charles B. Breed of the Massachusetts Institute of Technology presented a paper on the subject, "Causes and Control of Defects in Cement Concrete Pavements." *Attendance*, 35.

April 24, 1937. — Mr. C. A. Halverson, Consulting Engineer, Lighting Section, General Electric Company, spoke on the subject of "Highway Lighting." *Attendance*, 20.

October 27, 1937. — Mr. John V. McManmon, Senior Civil Engineer, Massachusetts Department of Public Works, spoke on the subject, "Roadside Development." *Attendance*, 17.

November 23, 1937. — This meeting was held in conjunction with the Designers Section. Mr. Donald W. Taylor, Research Associate in Soil Mechanics, Massachusetts Institute of Technology, presented a paper on the subject of "Stability of Earth Slopes." *Attendance,* 40.

The total attendance at all meetings during the year was 112. The average attendance was 28.

Respectfully submitted,

For the Executive Committee,

Thomas G. Giblin, *Clerk.*

Report of the Executive Committee of the Northeastern University Section

Boston, March 15, 1938.

To the Boston Society of Civil Engineers:

During the past year the Northeastern University Section has held four meetings or trips, as follows:

October 5, 6, 7, 1937. — Attendance at the three-day Fall Meeting of the American Society of Civil Engineers, Hotel Statler, Boston, Mass. *Attendance,* 30.

October 19, 1937. — Field trip to the Quabbin Project of the Metropolitan District Water Supply, Enfield, Mass. *Attendance,* 25.

January 13, 1938. — Meeting of Division B group. Lieutenant Roberts of the United States Coast and Geodetic Survey, speaker. *Attendance,* 23.

March 10, 1938. — Meeting of Division A group. Mr. Leslie Williams of the Bureau of Street Traffic at Harvard University, speaker. *Attendance,* 26.

The average attendance at meetings and trips was 28, and includes students, alumni, and members of the faculty of Northeastern University.

Respectfully submitted,

For the Executive Committee,

Harold E. Sanford, *Clerk.*

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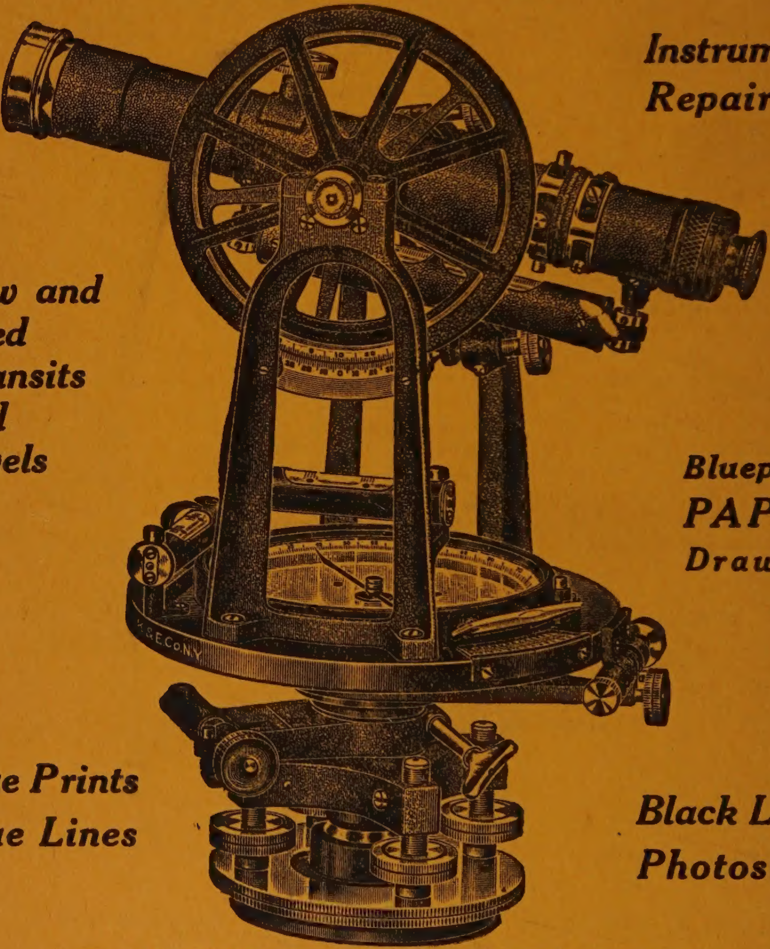

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